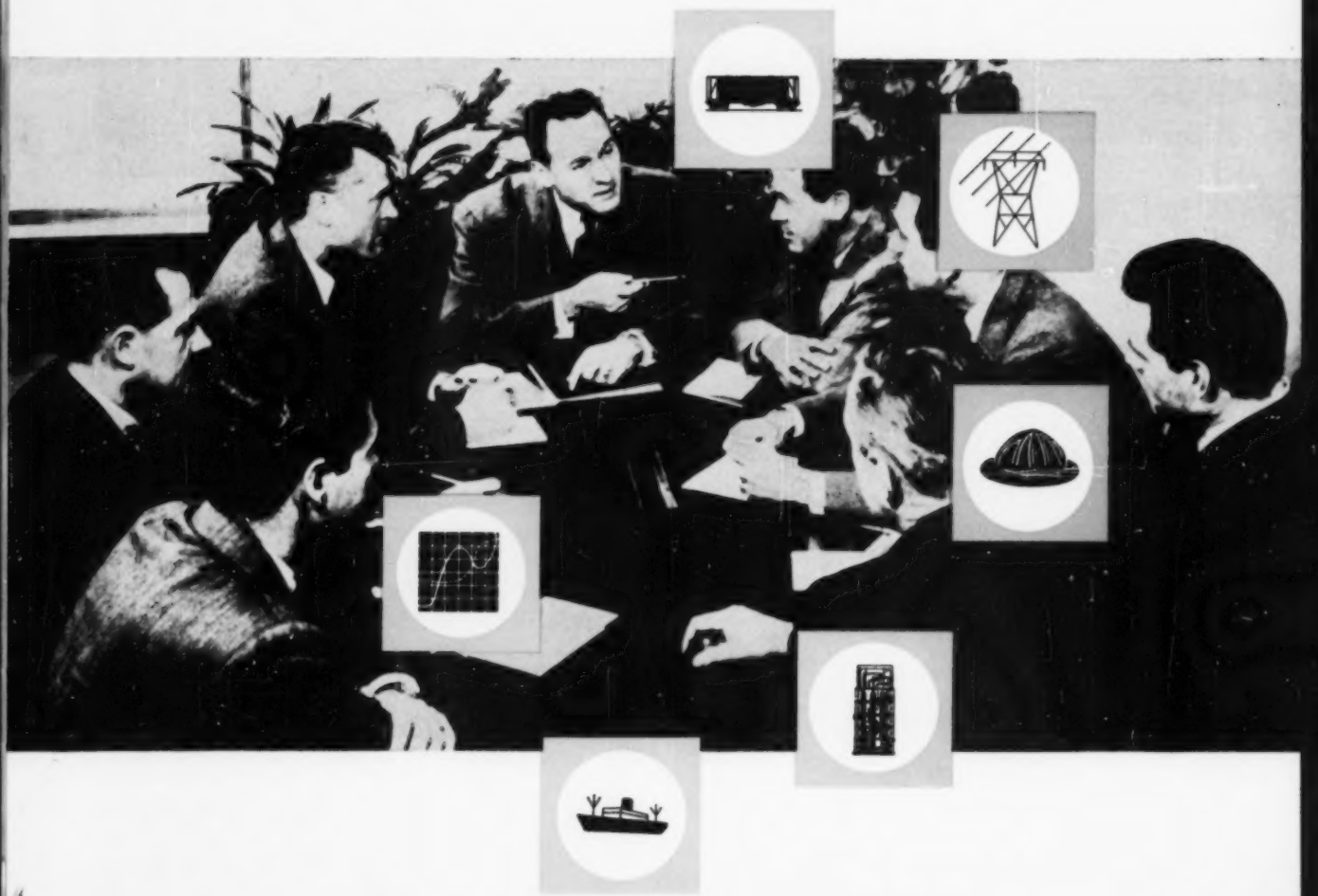
Chemical Engineering Progress

NOVEMBER 1954

the chemical engineer in management



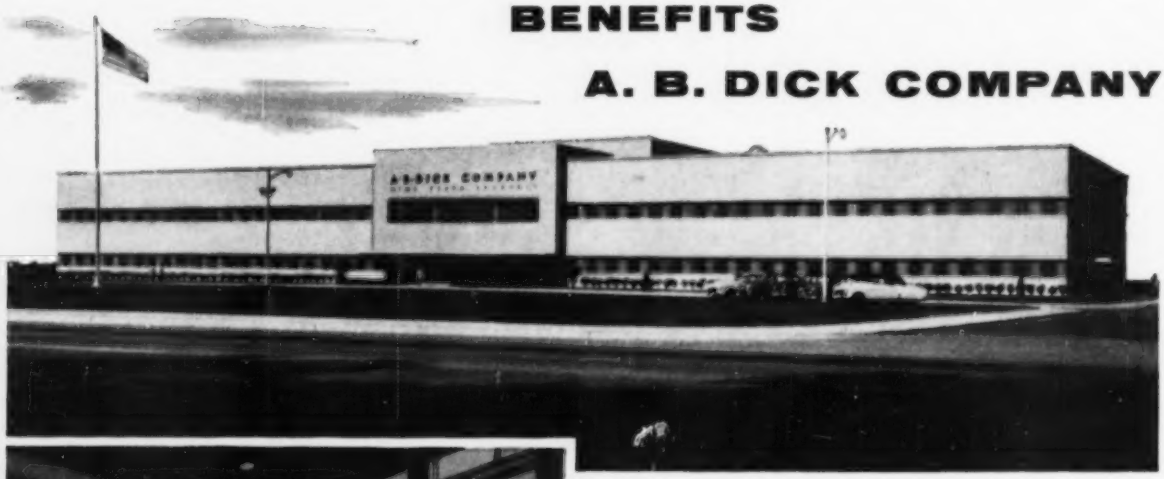
the chemical engineer at the annual meeting p. 35

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Back in 1942, A. B. Dick Company chose the COLUMBIA Activated Carbon system as the most efficient and economical method of recovering ether and alcohol vapors from the manufacture of mimeograph stencil sheets. And, over the years, the COLUMBIA Activated Carbon solvent recovery plant that was installed then has consistently recovered close to 90% of all the evaporated solvent. (The recovery plant itself operates at an efficiency of about 99%.)

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FEATURES OF THE COLUMBIA ACTIVATED CARBON SYSTEM

- *Recovers almost any low-boiling solvent or solvent mixture, safely, efficiently, even in extremely low concentrations, in the presence of water vapor, and at fluctuating rates of vaporization.*
- *The recovery plants are rugged, can be completely automatic, and can be designed for flexibility in converting from one solvent to another.*
- *Investment is moderate, and cost of recovery is low.*

Find out what solvent recovery can do for you. Write for the booklet, "Solvent Recovery by the COLUMBIA Activated Carbon System," Form 4410. In Canada: Carbide Chemicals Sales Company, Division of Union Carbide Canada Limited, Toronto.

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Chemical Engineering Progress

NOVEMBER, 1954

VOLUME 50, NO. 11

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Better Grading
OF DRY MATERIALS



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- Clean, Thorough Separations
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The Bar-Nun Rotary Sifter is a compact, self-contained, motor-driven unit for making particle-size separations on most all dry, powdered, granular, flaked or crystalline materials. The smooth, vibrationless operation requires less power and contributes to long life and low maintenance cost, even in continuous 24-hour service. Minimum floor space and head room are required.

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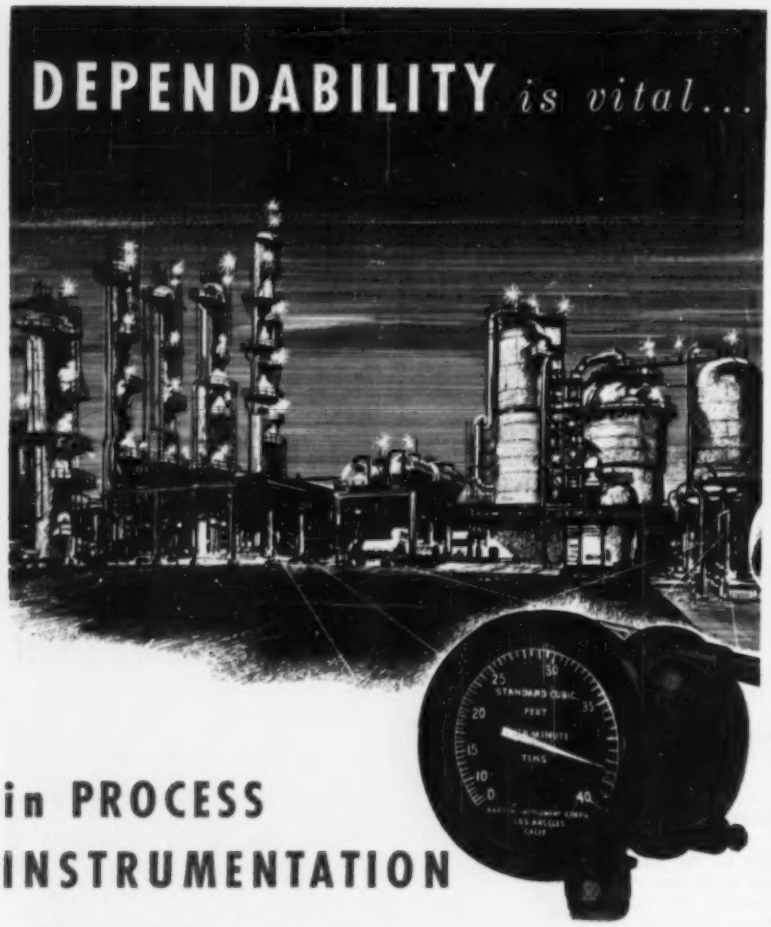
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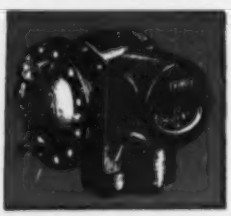
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BARTON Instruments, in measuring flow, liquid level and differential pressures are meeting the demands of industry with an enviable record. A typical example is the Watson Refinery of the Richfield Oil Corporation near Wilmington, California (illustrated above).

For complete information, contact one of the many experienced Barton Sales Representatives located in most principal cities. The Barton line is fully described in literature, available upon request. Write for Bulletins 11C4 and 211-1.



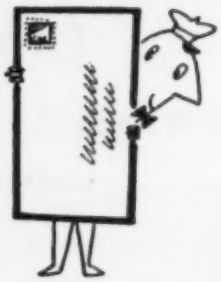
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LETTERS TO THE EDITOR



How Define Chemical Engineer?

I very much enjoyed the editorial in the in the September issue of C.E.P. entitled "What Is A Chemical Engineer?" I believe I agree that the chemical engineer today should not be defined in narrow terms of chemical or physical processes but rather that he should be defined in terms of a way of thinking or a kind of engineering philosophy. This brings me to the questtion that if this is the case, how would you incorporate these ideas in the formal membership requirements of the Institute? A year ago I was a member of a subcommittee which wrestled with the problem of possible changes in the requirements for what was then active membership; this became so complicated that we finally gave up and agreed to leave the wording unchanged. I would be interested in knowing whether you plan to implement the theme of your editorial by proposing that the membership requirements be altered accordingly, and if so what wording you would suggest.

ROLAND VOORHEES
South Charleston, W. Va.

C.E.P. plans no campaign urging that membership requirements of the Institute be changed. This is the members' prerogative and, if such changes come, they will come from the members themselves.

Perhaps it will be impossible to word membership requirements which could separate the chemical engineers employed in sales and management from salesmen and managers employed in chemical engineering. Certainly the criteria, if ever made, would have to be based on education, experience, and present occupation in chemical engineering.

Associate membership is now open to candidates who are executives in enterprises involving chemical engineering. Candidates for Member, however, "must be actively engaged in chemical engineering," which the Constitution defines as "the application of the principles of the physical sciences together with the principles of economics

(*Continued on page* 8)

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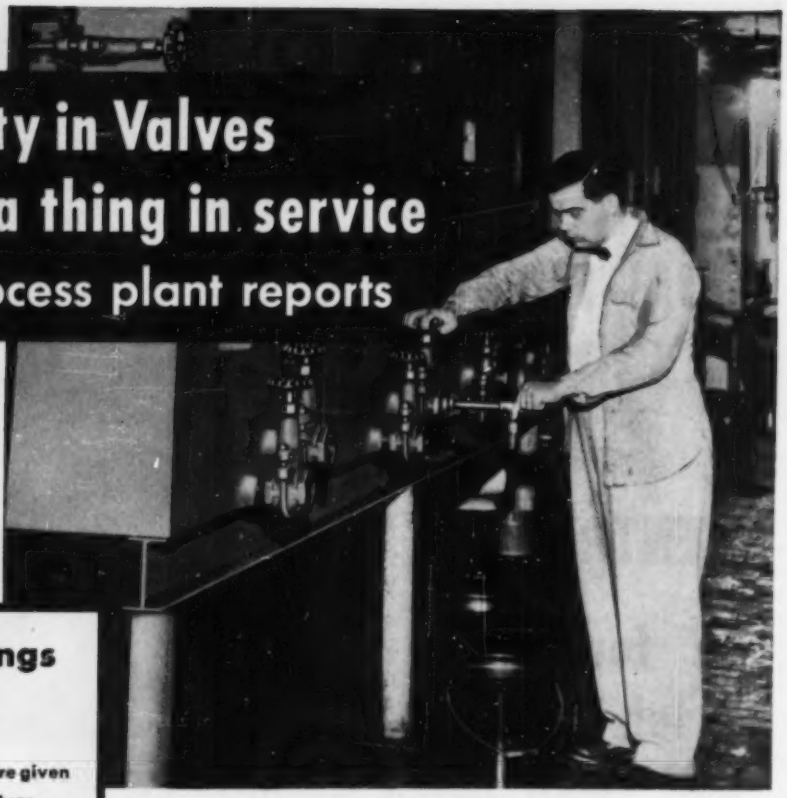
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Similarity in Valves doesn't mean a thing in service

...Chicago process plant reports



The Installation

At Hysan Products Co., Chicago manufacturer of liquid waxes, pine oil and coal tar disinfectants, liquid soaps, insecticides and various chemical specialties—where Crane clamp gate valves have been installed on all process and storage piping.

Valve Service Ratings

SUITABILITY: Performance-proved

FEATURES: Tight seating

MAINTENANCE COST: Only routine care given

SERVICE LIFE: Many times former valves—still like new

OPERATING RESULTS: Costly loss and trouble stopped

AVAILABILITY: Crane Catalog item—No. 488

The Valve

Crane clamp gates are of rugged design, with seating surfaces machined to close tolerances. That's why they provide long-lasting, tight closure, even where operation is frequent and fluids are hard to hold. Many patterns to choose from in these compact valves—all iron or brass-trimmed. Consult your Crane Catalog or your Crane Representative.



The Case History

Longest service given by similar type valves formerly used was from 2 to 6 months. They failed to hold tight at seats and disc under daily operation of 3 to 12 cycles. Valve maintenance and replacements were excessively costly—as were down-time losses. Leaky valves on tank lines forced repeated transfer of storage stock. Up to 3 men were needed to make valve repairs.

Only when the plant switched to Crane No. 488 clamp gate valves was the trouble stopped. Installed more than a year ago, the valves show no sign of wear or leakage. Only an occasional pull-up on the packing nut is needed—and only one man for all piping maintenance.

What's the answer? Better quality valves, obviously—the only way to assure better service and lower ultimate cost.

THE BETTER QUALITY . . . BIGGER VALUE LINE . . . IN BRASS, IRON, STEEL

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Branches and Wholesalers Serving All Industrial Areas

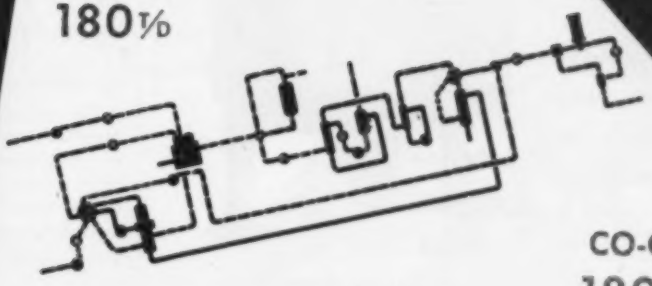
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and
construction

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Deere ○
180 T/D



CO-OP ○
180 T/D

Conselho □
(Brazil)
100 T/D

Grace □
250 T/D

FOSTER WHEELER
165 BROADWAY, New York 6, N. Y.

○ "on stream"
□ building

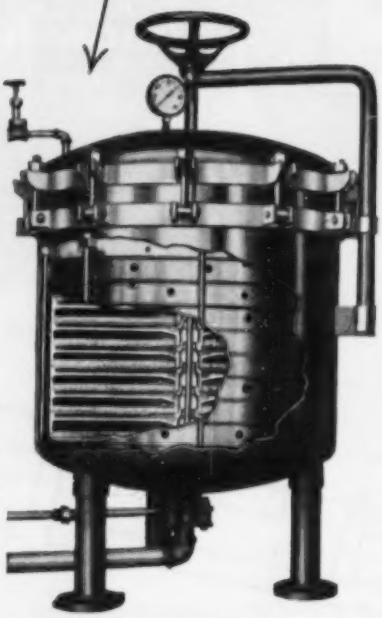
765

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versatile adaptability

. . . for all fine filtering

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HORIZONTAL PLATE
FILTERS



Versatile adaptability make this filter the logical choice of filtration engineers for difficult filtering problems.

Every filtering job usually presents an individual problem involving a combination of various kinds of screens, papers and filter aid. Frequently temperatures are encountered that call for a brine or steam jacketed tank. Linings; plastic or rubber may be needed, with tank and plate metals to fit the product such as mild steel, monel, nickel, stainless steel, bronze or Hastelloy. Constructed to meet ASME specifications when required.

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Constant filtering quality is maintained from start to the end of the cycle, no break through can occur in a Sparkler Horizontal Plate filter.

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Place your filtering problem in the hands of our filtration engineers. They have developed many successful methods of filtering difficult materials and may be able to prescribe a solution to your problem without wasteful experimentation.

Write Eric Anderson for personal attention

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Canadian Plant, Galt, Ontario
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For over a quarter of a century, engineers and manufacturers of a complete line of industrial filtration equipment.

LETTERS TO THE EDITOR

(Continued from page 4)

and human relations in the fields that pertain directly to processes and process equipment in which matter is treated to effect a change in state, energy content, or composition." A knotty problem, but we feel it will some day be solved through the members themselves.

F.J.V.A.

"There Is No Frigate Like a Book [or C.E.P.] to Take Us Lands Away."

I thoroughly enjoyed Professor Dodge's article "A Chemical Engineer in Spain" that appeared in the September issue of Chemical Engineering Progress. As a former student of Chemical Engineering under Professor Dodge's guidance at Yale University, I know by experience that his lectures are always extremely interesting. I want to take this chance to congratulate you and the rest of your staff for the wonderful magazine that you are putting out.

Havana, Cuba — ROBERTO C. GOIZUETA

An Addition to the Seal-less Pump Paper

The article on Seal-less Pumps, in your September issue, neglects to mention that the Magnaflow pump has been manufactured in the United States since the pump was developed some seven years ago. Any inquiries should be referred to Magnaflow Pump Corp., Box 111, Westfield, New Jersey.

Westfield, N. J. — S. H. GAMP

A Complaint—An Explanation

I have been noticing a trend in the publication of Chemical Engineering Progress towards smaller and smaller diagrams If it continues the diagrams will be completely unreadable unless a magnifying glass is included with subscription.

I can appreciate the limitations of space in modern technical journals. However, the prime purpose of technical journals is the dissemination of information. Small, difficultly read diagrams and charts discourage their reading. I would appreciate it if an effort was made to enlarge the graphic material in the journal.

I should like to commend the well designed covers on Chemical Engineering Progress. Simplicity and very pleasing to the eye, these covers are a welcome change.

Princeton, N. J. — WILLIAM C. COHEN

∫ The onus is often on the authors. The original lettering on graphs and line illustrations is not intended for the amount of reduction the chart itself will take; thus, compromise is necessary with the resultant imperfect readability. [Editor]

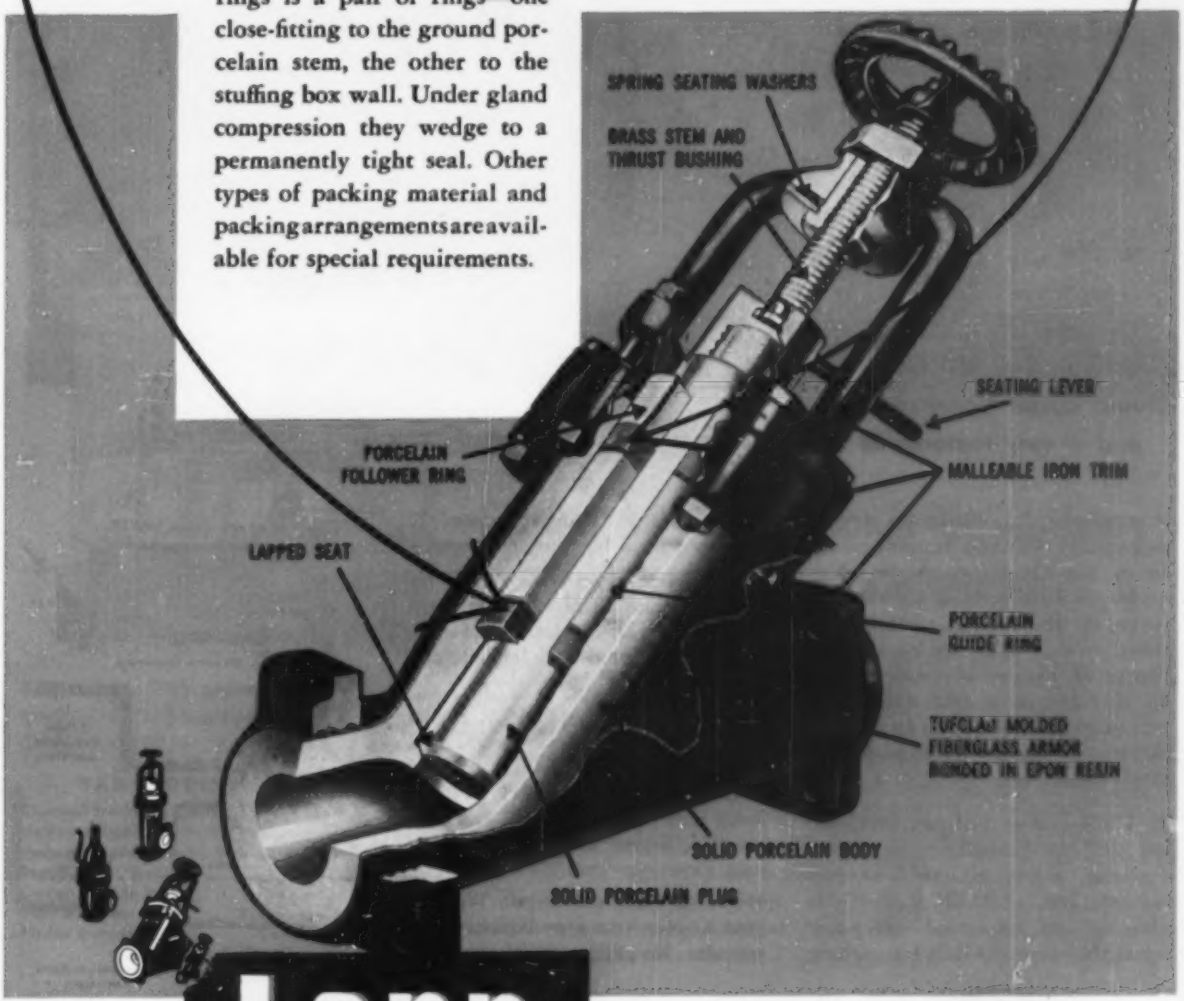
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..."all-service"

...maintenance-free

in Lapp Valves

Solid, unfilled Teflon, in a wedge-ring arrangement, provides a packing for Lapp Porcelain valves which is long in serviceability, short on maintenance requirements. Each of the two sets of Teflon wedge-rings is a pair of rings—one close-fitting to the ground porcelain stem, the other to the stuffing box wall. Other types of packing material and packing arrangements are available for special requirements.



Lapp

PROCESS EQUIPMENT

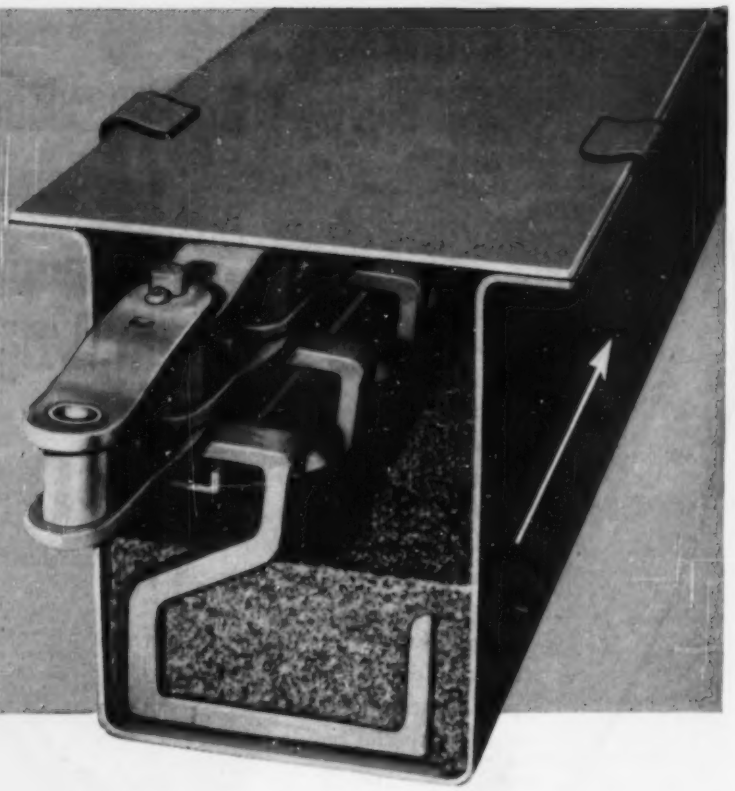
Chemical Porcelain Valves • Pipes • Raschig Rings
Polyphenol Chemical Processing Pumps

Y-valves, angle valves, flush valves, safety valves, and plug cocks of Lapp Porcelain have standard bolt-circle flanges for easy connection to all piping and equipment. Write for bulletin with complete description, characteristics, and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 338 Wendell St., LeRoy, N. Y.

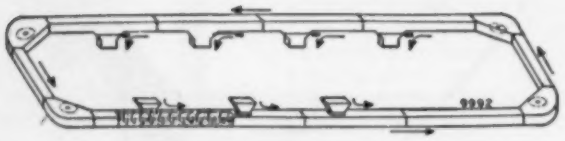
CONVEYS ANYTHING

Economically from COAL to CORNSTARCH

with simultaneous pick-up or discharge at one or many points... without dust or contamination... in small space



This is an S-A REDLER Horizontal Closed Circuit Conveyor— and a very remarkable unit it is!



It conveys in four directions — can pick up and discharge at many points on its run simultaneously or selectively—does the work of several conveyors of other types. It is fully enclosed — dust-tight and contamination-proof. Because it moves materials *in mass*, in a solid column, it minimizes dust formation and degradation and practically eliminates explosion hazards.

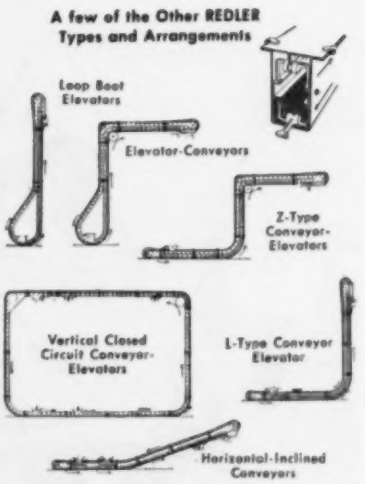
It is self-feeding and can be choke fed without jamming. Any excess material simply recirculates until needed. The REDLER is also self-cleaning, an important advantage when the operation calls for running various materials in sequence. It makes an ideal blending conveyor.

Unusually compact, REDLERS require a minimum of structural support. They can be easily and economically adapted to practically any plant layout.

The closed circuit REDLER is just one of many types furnished by S-A. If you handle or work with any kind of granular, pulverized, flaky or small lump material, a REDLER can help you do it better, cleaner and at lower cost.

Write for Catalog No. 140. We'll be glad to give you a preliminary cost estimate. No obligation, of course.

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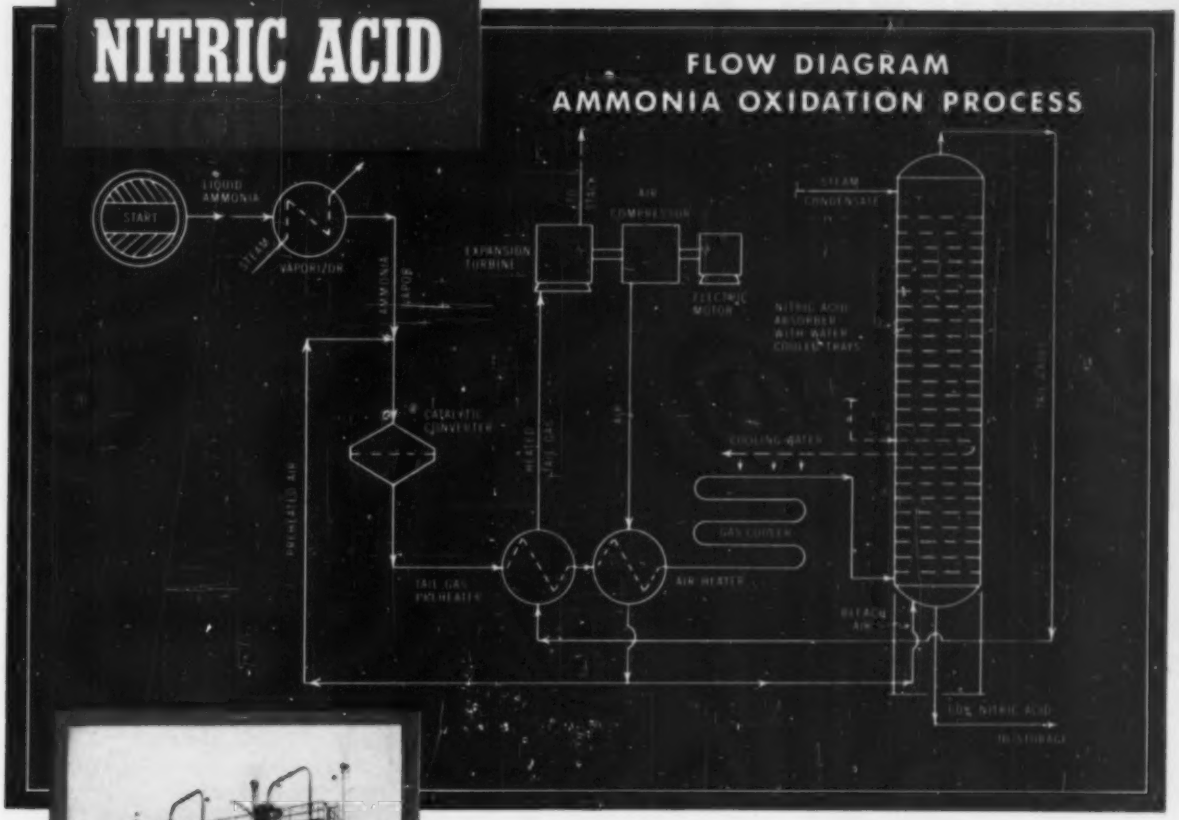
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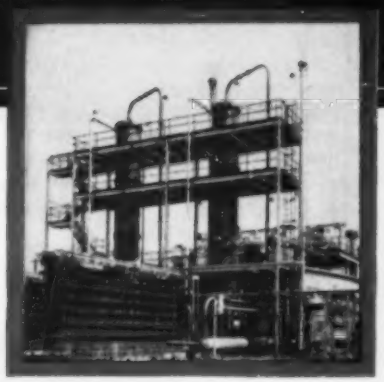
Engineering Division
Specialists in the design and manufacture of all types of bulk materials conveying systems.

Standard Products Division
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Sealmaster Division
A complete line of industrial ball bearing units available in both standard and special housings.

NITRIC ACID





Nitric acid installation built by Girdler at Mississippi Chemical Corporation's ammonium nitrate plant.

Girdler builds Ammonia Oxidation Plants using Du Pont process

GIRDLER nitric acid plants employ the well-known Du Pont process, using high-pressure catalytic oxidation, to produce nitric acid on a consistent basis. These plants offer greater economy, in both investment and operating costs, than atmospheric or low-pressure units. With the high-pressure process 55%-60% nitric acid is produced with efficient use of catalysts, and with lower utility requirements.

These Girdler plants, incorporating all recent improvements resulting from Du Pont experience, are available in various capacities.

Girdler assumes responsibility for all phases of such process projects: design, engineering, and construction. Write for new booklet giving detailed description of Girdler nitric acid plants.

GIRDLER DESIGNS processes and plants
GIRDLER BUILDS processing plants
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GAS PROCESSES DIVISION:

Chemical Processing Plants
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Heads up to 350 ft.

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with a

JOHNSTON UNIT-LINE SUMP PUMP



This Johnston Pump is one of the many popular and dependable Johnston Models.

—easy to install
—economical to operate

Because of multi-stage and centrifugal diffusion vane construction with balanced hydraulic forces, the Johnston Unit-Line Sump Pump is the only sump pump that can pump up to 350 ft. of head — 2½ to 3½ times that of ordinary sump pumps. *Only* Johnston makes a *packing-less* and *seal-less* Unit-Line Sump Pump.

Designed by the engineers who invented and developed the vitreous enameled bowl, Johnston Pumps are backed by half a century of experience and know-how as one of the world's leading manufacturers of vertical turbine pumps. *Mail coupon today and learn how Johnston can solve your industrial pumping problems.*

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CEP

NOTED AND QUOTED

Role of Scholar in American Life

Taken together the activities of teaching, research, and scholarship are a principal architect of American greatness in all fields, political as well as scientific, cultural as well as technological. . . .

In defending education . . . it is of vital importance that we do not take the false position of asserting that our professors are innocent of any connection with the great changes that have transformed the life of the American people. . . . It is no juggling or balancing of phrase to admit frankly that scholarship and research are related both to stability and to change. Scholars are by definition both conservative and liberal, and sometimes say or discover things that are revolutionary. They are paid to experiment outside the scope of traditional experience and knowledge. They defend the past and yet open the road to the future. To destroy the affinity of research and scholarship with the forces of change would be to visit the curse of sterility upon the nation itself. In every pursuit, for all our great political, social, economic, and military purposes, we have an insatiable hunger for the knowledge and understanding that permit us to meet the challenges and opportunities of this stupendous age.

Cornelis W. de Kiewiet
The Saturday Review

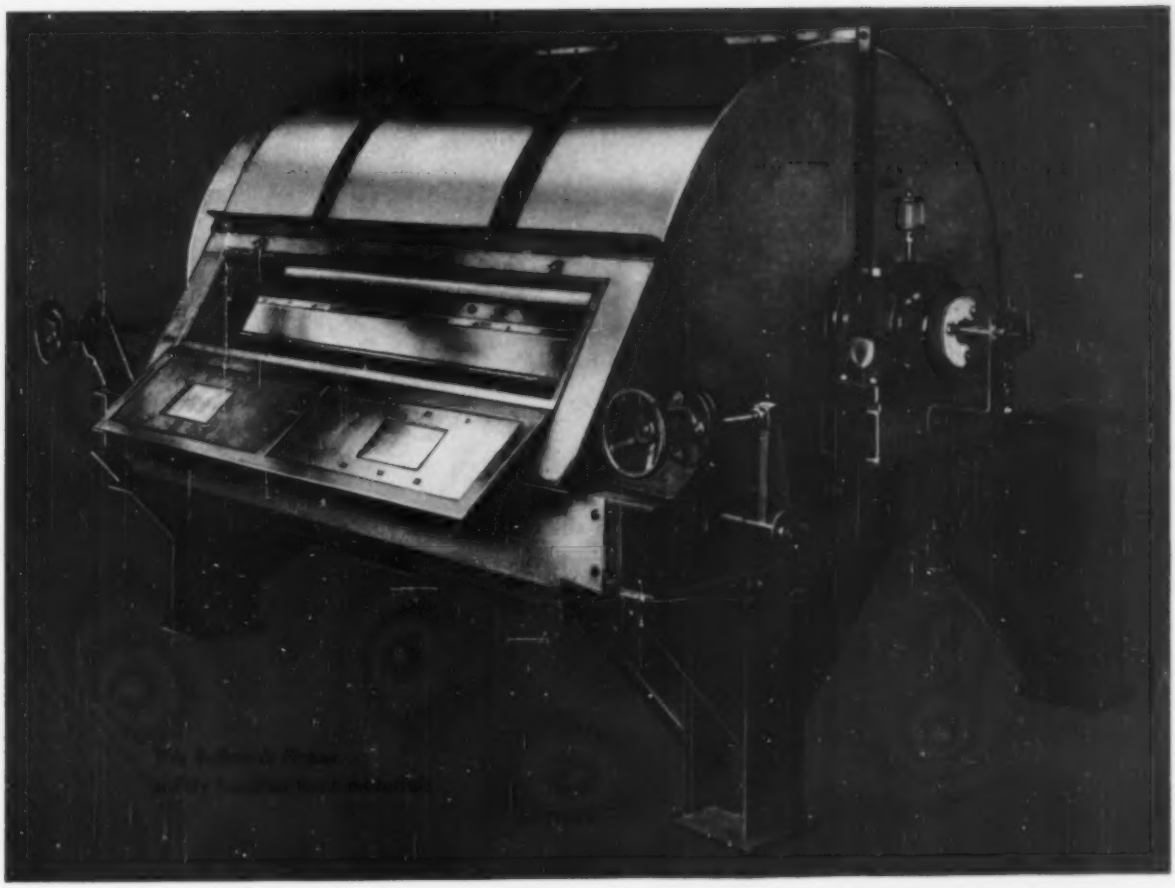
The author of this guest editorial wrote an article for C.E.P. (May, 1952, page 40) titled "Manpower—Only Part of the Problem." The question of the hour at that time was manpower and the production of high-level skills. Dr. de Kiewiet, president of University of Rochester, warned against the shortage of scientists, "those research people who provide the basic data that engineers use." Herein he made a plea for the great American university, and went on to state that "the application of science to technology, the bridges that you build between the things that are known and the things that are used, goes on externally. That is something that will go on as long as men, as we know them, exist."
[Editor]

28 Years To Go

The *Times* [London] . . . takes the gloomiest view possible of the future of letters, and thinks that a hundred years hence there will only be a few eccentrics reading letters and almost everyone will be studying the natural sciences.

Matthew Arnold, 1882

(More Noted and Quoted on page 22)



Buflovak Flakers provide continuous operation ... large capacity ... finished product ready for end use



Send for your copy of Catalog 352 to get complete information about Buflovak *Flakers.*

These flakers are used extensively in the chemical industry for producing a flaked or granular material from a variety of products. The molten liquid is applied to a revolving drum, is quickly cooled and continuously removed by a stationary knife. This process offers continuous operation, high capacity and finished product free from lumps.

Sounds simple and easy, doesn't it? But the smooth, efficient operation of *Buflovak* Flakers throughout the chemical industry is often the result of careful pre-testing in the Pilot Plant of our *Buflovak* Research and Testing Laboratory.

What equipment is required for the safe processing of toxic or corrosive materials? What are the most effective cooling methods for products of low or high melting point, and all the products in between? What other modifications may be required for the most efficient processing of your product?

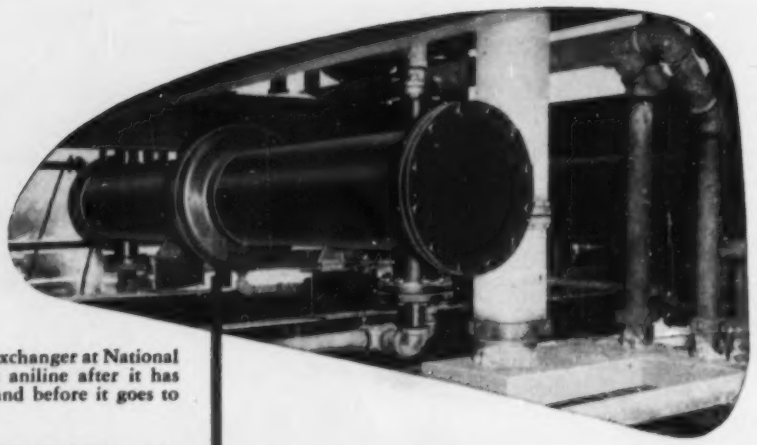
All of these questions can be answered by *Buflovak* engineers, who have an extensive knowledge of processing methods ... plus the facilities for pre-testing equipment and processes, under production conditions, in our completely equipped Pilot Plant.

These facilities are always available to help you with any flaking problem.

BUFLOVAK EQUIPMENT DIVISION
BLAW-KNOX COMPANY
1567 Fillmore Avenue, Buffalo 11, New York

BLAW-KNOX

BUFLOVAK PRODUCTS: evaporators • dryers (atmospheric and vacuum) • solvent recovery and distillation equipment • chemical plant equipment • food processing equipment • kettles • fabricated processing equipment • vulcanizers ... plus a complete Pilot Plant for pre-testing processes and products.



• ADSCO Heat Exchanger at National Aniline sub-cools aniline after it has been condensed and before it goes to storage.

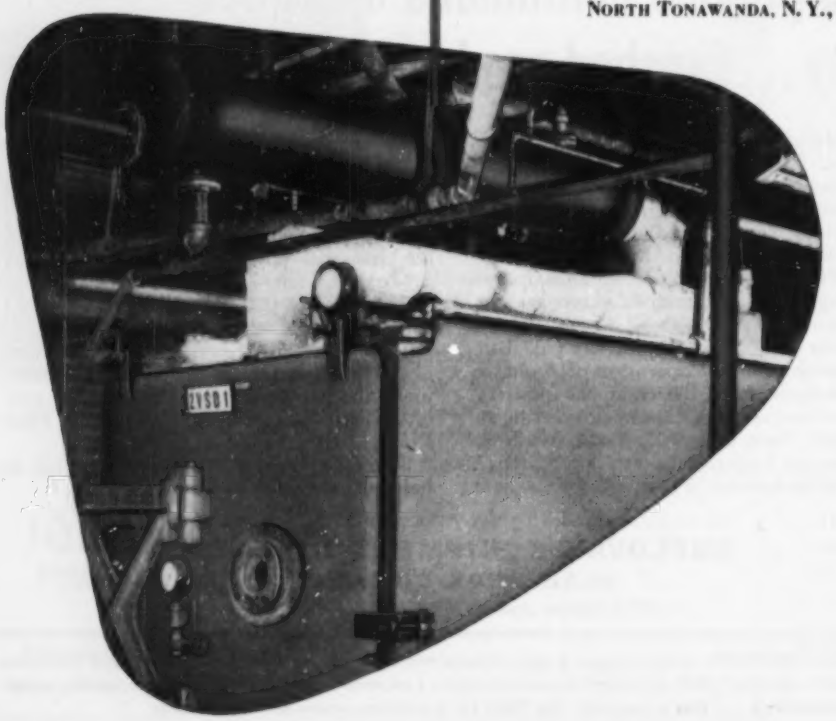
WHERE A HEAT EXCHANGER MUST BE GOOD

• ADSCO Heat Exchanger (insulated) above vacuum drier at National Aniline condenses organic acid vapor in tubes with water or brine in shell. Exchanger equipped with shell expansion joint.

The ADSCO Heat Exchangers shown on this page are installed in the Buffalo, N. Y., plant of the National Aniline Division of Allied Chemical & Dye Corporation. The manufacturing processes of National Aniline require engineered equipment of the highest caliber. . . . ADSCO, in business since 1877, offers the chemical processing industry a complete line of carefully-engineered heat exchangers built to customers' specifications or to our recommended designs. Inquiries are cordially invited.

AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES
NORTH TONAWANDA, NEW YORK
PLANTS
NORTH TONAWANDA, N. Y., AND RICHMOND, CALIF.



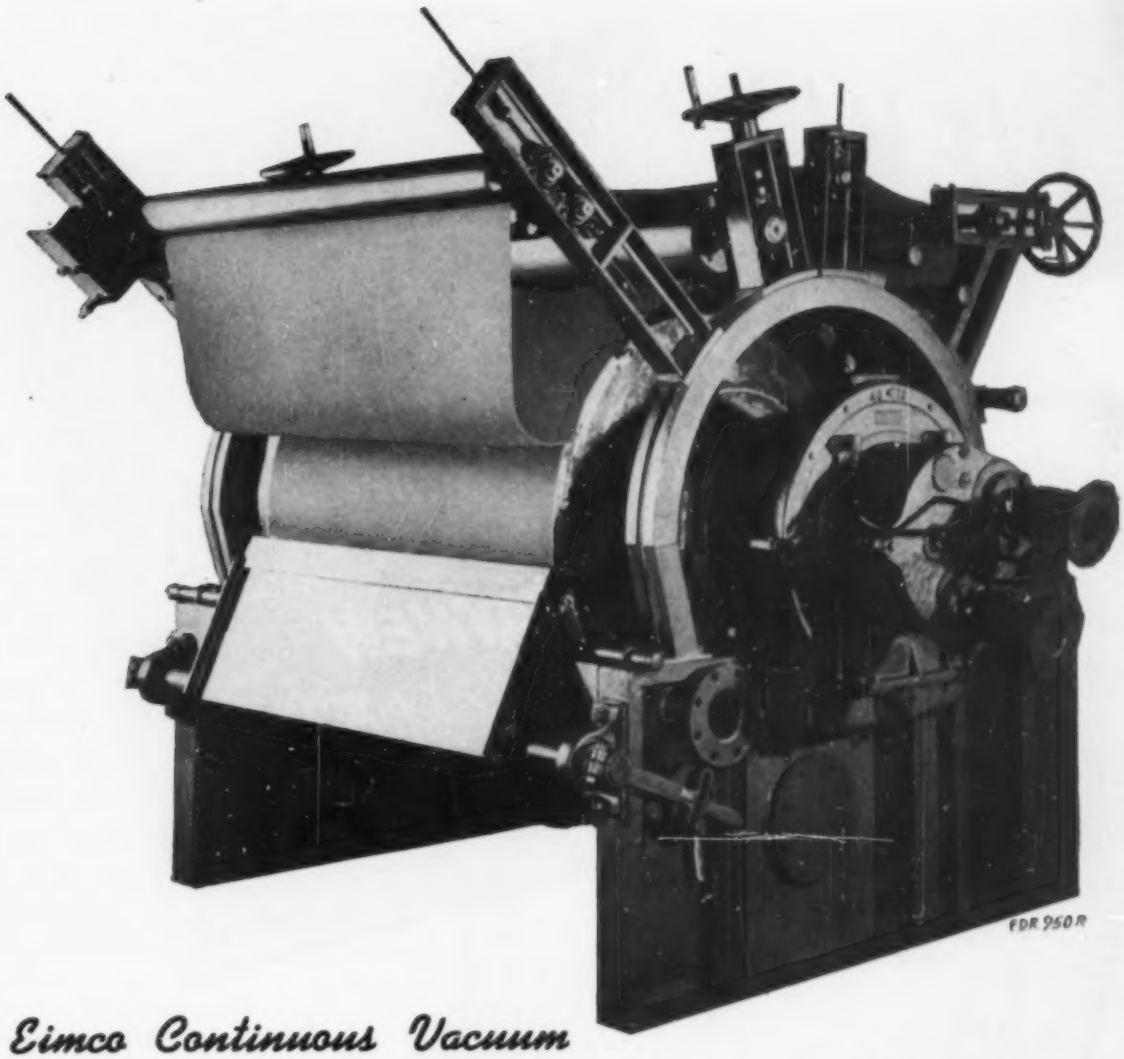
ADSCO ENGINEERED PRODUCTS

EXPANSION JOINTS

TRAPS

STRAINERS

SEPARATORS



Eimco Continuous Vacuum Filters Using Compression Blankets

Another example of the many types of Eimco Continuous Vacuum and Pressure Filters. Filters of this type have been in use in many plants and provide many advantages where the material to be filtered produces a flocculent solid type cake.

Eimco filters of the type shown above, introduce a wash spray to the cake formation immediately after it emerges from the liquid in the tank and the compression blanket binds the cake to drum within a few inches of the slurry level. The blanket covers the cake to the blow zone above the scraper blade.

This type Eimco filter prevents cake cracking, greatly improves washing and on some types of filter cake, will reduce moisture content in the cake by 8-10%.

Write for more information.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Texas Birmingham, Ala. Duluth, Minn. Kellogg, Ida. London, Eng. Paris, France Milan, Italy

D-80

You Can't Beat An Eimco!

NEW!





SEND FOR THIS

12-PAGE BULLETIN D-1L

JUST OFF THE PRESS

This bulletin contains specifications, engineering and performance data, photos and descriptions of recommended types of filter media, check list of liquids that can be filtered and other helpful data.

- CUTAWAY DRAWINGS
- LIST OF LIQUIDS THAT CAN BE FILTERED
- GENERAL SPECIFICATIONS
- PERFORMANCE DATA
- TYPES OF FILTERING MEDIA
- INSTALLATION PHOTOS AND DATA
- PROJECT DATA SHEET

DOLLINGER PROTECTO-MOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

79 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

GIVES YOU ANY RPM—
AND ONLY 14¼" HIGH!

FRACTIONAL HORSEPOWER

VARIABLE SPEEDS—IN SMALLEST PACKAGE

HERE'S the new variable speed motor that cost-conscious plant operators have long sought. It's the light weight U. S. Varidrive, Type VA, compactly dimensioned to occupy least space, yet suitable for rugged industrial duty just like the larger HP Varidrive line. Compact dimensions and light weight now make built-in application of variable speeds practical. You can mount it right on your machine, close in; or in any position on floor, wall or ceiling, with or without remote control.

4 TO 10,000 RPM
IN RATIOS UP TO 10:1



Quick, Accurate Dial Control

Full speed range instantly obtained in less than one turn of dial handle. The stationary dial plate is precisely calibrated for close speed setting, yet easily visible from a distance.

Gets You More Production

You can greatly increase the performance and output of your machine using fractional horsepower with Type VA. You can now get the exact speeds needed for each operation. Your operator can control the speed to a split rpm to accomplish better workmanship and to actually gain more output. This amazing motor invariably repays its low-cost investment within a few weeks.

14¼" High x 8½" Wide
Weight—87 Lbs.
Easiest Dial Control
Single and 3-Phase

U.S. VARIDRIVE MOTOR

Bulletin Chock-full of Facts

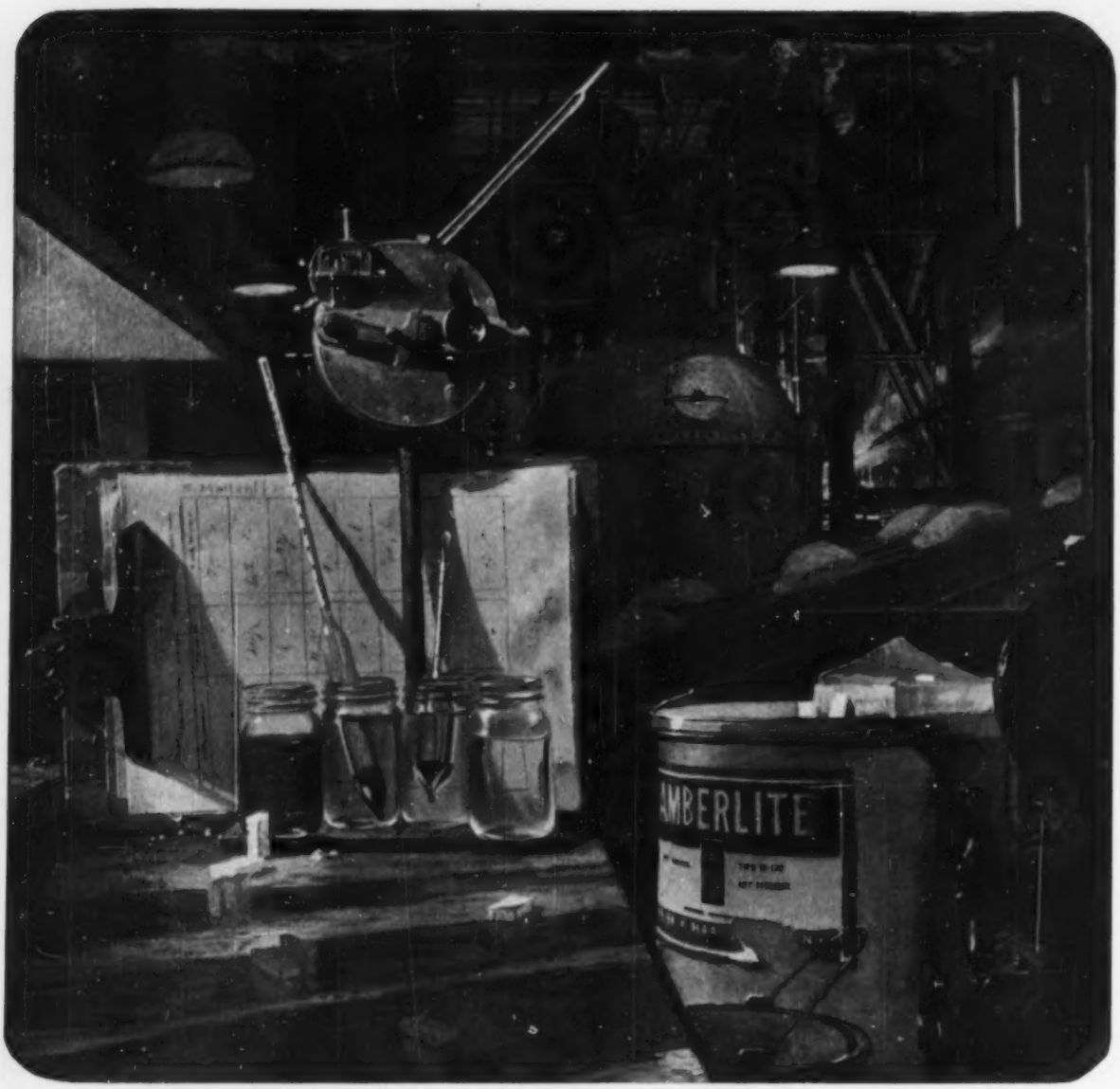
You'll want to study the internal workings of this revolutionary small horsepower motor—see how it works, note the high excellence of materials and the advanced engineering skill that makes Type VA the wonder motor. All the facts are interestingly presented in Bulletin No. 1797. Engineering details and many types shown.

U. S. ELECTRICAL MOTORS INC.
Los Angeles 54, Calif. Milford, Conn.



REQUEST VARIDRIVE BOOKLET

U. S. Electrical Motors Inc. CEP-11
Box 2058, Los Angeles 54, Calif. or Milford, Conn.
☐ *Send Varidrive Bulletin 1797*
NAME_____
COMPANY_____
ADDRESS_____
CITY ZONE STATE



Sugar by the ton: 99.99% pure

There aren't many chemicals—let alone foodstuffs—as chemically pure as sugar prepared from sirups treated with Amberlite® ion exchange resins. These resins remove ash from cane sirup solutions, cut down sugar loss in molasses, yield sugar of the highest quality.

Other products, too, benefit from proper treatment with the Amberlite ion exchangers. Soft curd milk for infants may be produced from cow's milk, for example. Stabilized cream and condensed milk, readily soluble in hot drinks, may be prepared. Crude glycerin can be converted to C.P. grade by an ion exhange process.

The list is long. Gelatin, amino acids, fruit drinks, bland sirups from fruit wastes, vitamins, dextrose sirups, and others may be purified at low cost by means of Amberlite ion exchange.

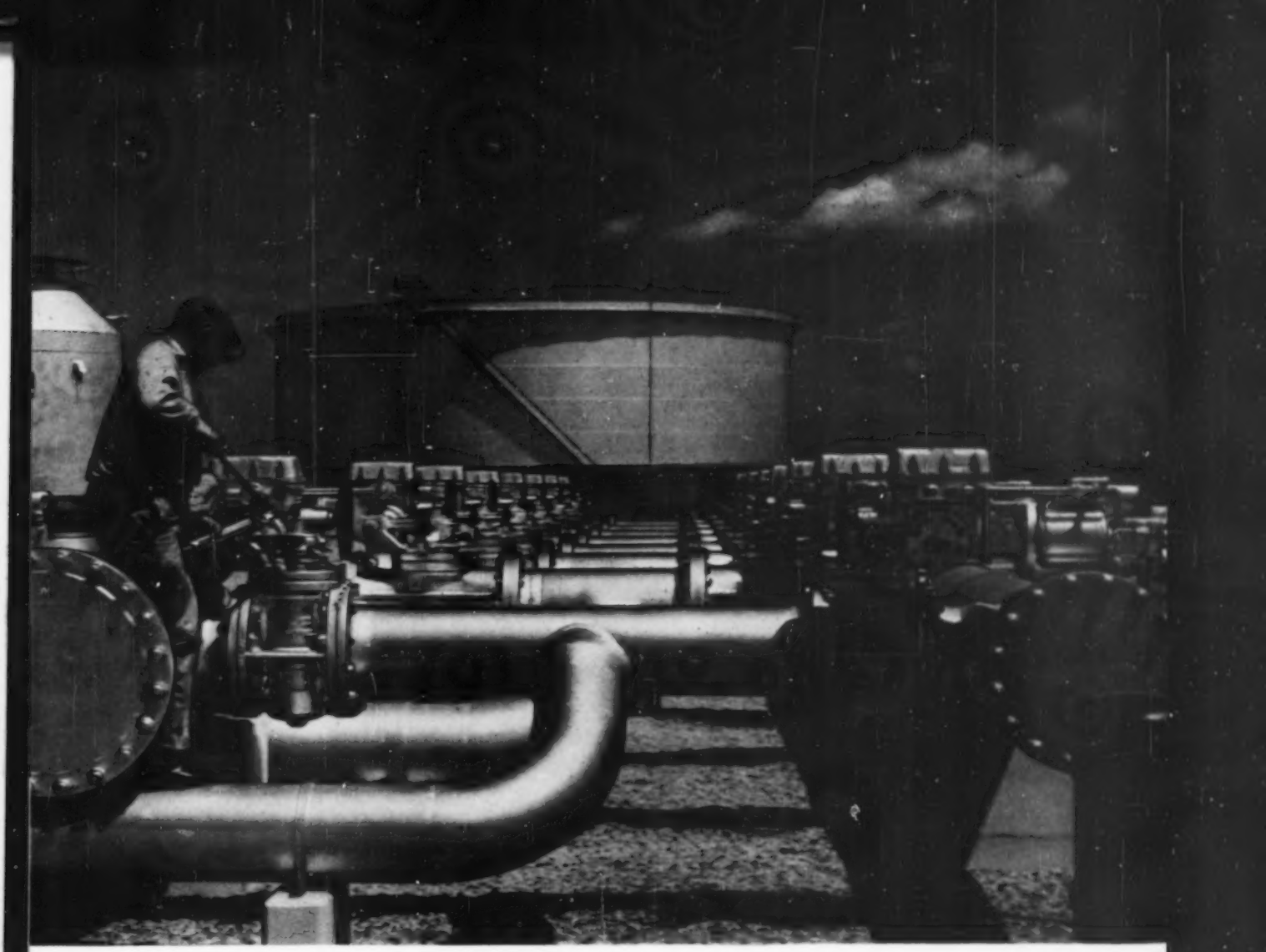
Why not write us about your problem . . . ask us about Amberlite ion exchange resins? Take this opportunity to find out why, in ion exchange, the *right* way is the *Amberlite* way.

Ask for "Amberlite Ion Exchange," 16 pages of technical information on the applications for ion exchange in industry.



ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION, PHILADELPHIA 5, PENNSYLVANIA



PICTURE OF MAINTENANCE COSTS BEING LOWERED

Every plant that keeps complete records comes to the same conclusion—periodic valve lubrication *saves* money; it's valve failure and replacement that sends maintenance costs skyward.

That is the basic fact behind the Rockwell-Nordstrom valve design, for the internal lubrication system eliminates most reasons for valve failure—Rockwell-Nordstrom lubricant *prevents* galling, jamming, abrasive wear, and seepage.

Systematic lubrication of Rockwell-Nordstrom valves with the right Rockwell-Nordstrom lubricants inevitably leads to lower operating costs. There is no substitute for Rockwell experience—use it to save money on valves. *Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.*

THREE WAYS
THE NORDSTROM LUBRICANT WORKS

1. Lubricant surrounds each valve port with a vapor tight pressurized seal. **Nordstrom valves stay tight.**
2. Lubricant acts as hydraulic jack—a fast quarter-turn to open or close. **Nordstrom valves operate quickly.**
3. Lubricant coats the plug for sliding action—no wear-producing wedging. **Nordstrom valves operate easily.**

Rockwell Built

NORDSTROM VALVES

Lubricant-Sealed for Positive Shut Off



WHICH PRODUCT IS EASIEST TO MAKE?

Every manufacturing process has its own special problems. There's no fair way to compare the difficulties of processing paint and paper, or of synthetic rubber and synthetic textiles, for instance.

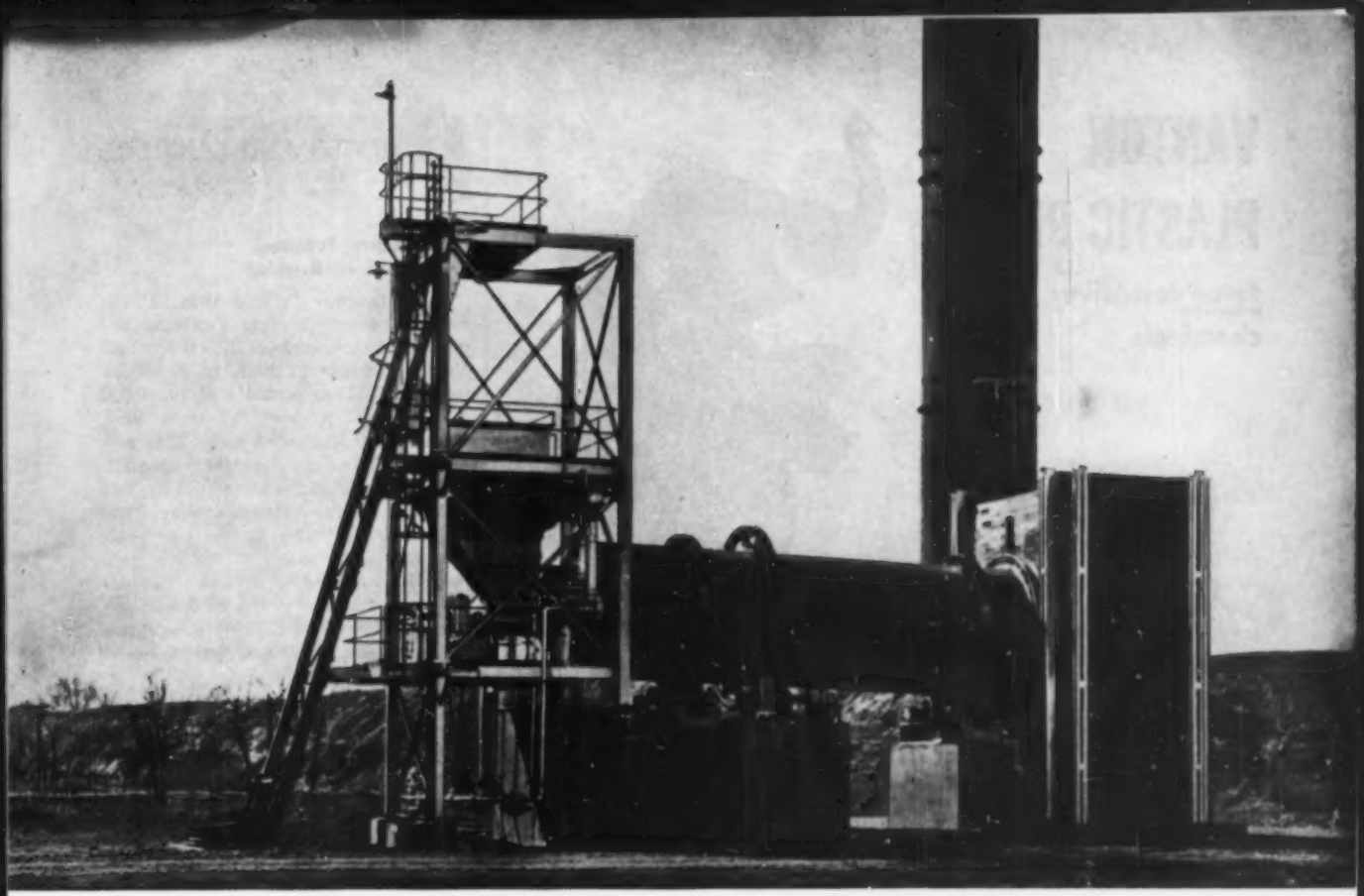
In every process industry, too, there are special problems of flow control, and no matter what claims you read, there is no such thing as an all-purpose valve.

Undoubtedly, Rockwell-Nordstrom valves approach that point more closely than others because they use the Nordstrom-originated principle of internal lubrication. Rockwell-Nordstrom lubricants seal tightly in gas, liquid or slurry service, and at the same time make operation easy, and eliminate galling or seizing.

Further, Rockwell-Nordstrom makes the widest range of sizes, pressure classes, metals and lubricants, so that for any process, you're wise to check first with *Rockwell Manufacturing Company*, *Pittsburgh 8, Pennsylvania.*

Nordstrom Valves

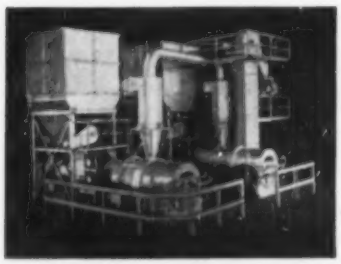
Another Quality ROCKWELL Product



rotary kiln Burns Waste



Special Stainless Steel Batch Dryer for Drying Fine Catalyst without Dust Loss.



Two Complete Drying Systems, Can Be Operated Together—or Singly—to Meet Varying Plant Requirements.

. . . provides easy, economical, smoke-free disposal of still and tank bottom sludge, office waste, rags, food waste, and other oil refinery, industrial or commercial wastes.

● Material to be burned is raised in the skip bucket and fed into the brick lined kiln with a specially designed feeder. Kiln can be rotated at various speeds, permitting the burning time to be altered to meet changing requirements. Ashes are collected in the brick chamber. An auxiliary oil burner is provided for use when the materials are not readily combustible. Consult Bartlett-Snow on your next drying, cooling, calcining, waste disposal or other heat engineering problem. Our wide experience can save you both time and money!

DESIGNERS ENGINEERS

BARTLETT B-SNOW
CLEVELAND 5, OHIO

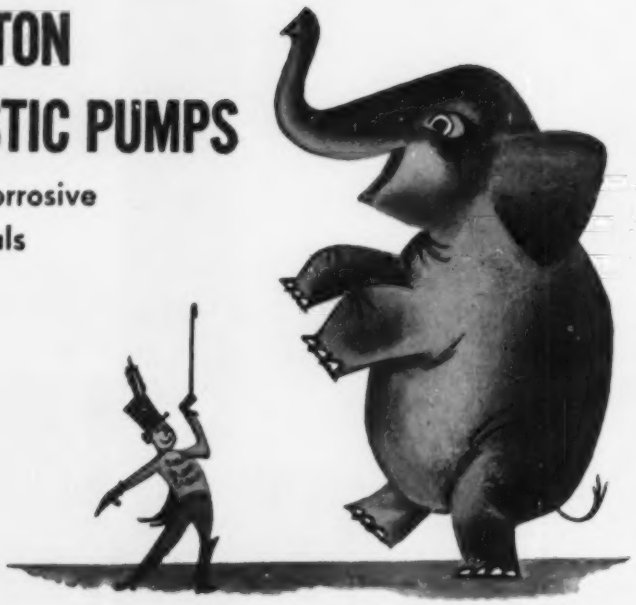
FABRICATORS ERECTORS

Dryers • Coolers • Calciners • Kilns

"Builders of Equipment for People You Know"

VANTON PLASTIC PUMPS

tame corrosive chemicals



Flex-i-liner **PUMPS** are becoming industry's standard for those difficult to handle corrosive solutions and abrasive slurries, such as HCl, HF, NaOH, H_2SO_4, distilled H_2O, $FeCl_3$, HCOOH, and $Al_2(SO4)_3$, because their unique design eliminates stuffing boxes, shaft seals, gaskets and check valves.

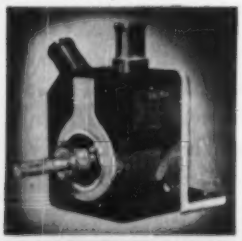
NO METAL IN CONTACT—The only parts in contact with the fluid being pumped are the outer surface of the durable precision molded flexible liner and the inner surface of the pump body block, both of which are available in a wide selection of corrosion and contamination resistant materials.

FLEX-I-LINERS:
● Pure gum rubber ● Natural Rubber ● Neoprene
● Hycar ● Buna N ● Silicone ● Vinyl ● Compar

BODY BLOCKS:
● Polyethylene ● Bakelite ● Buna N
● Lucite ● Unplasticized PVC

● Available in stainless steel for special applications.

Flex-i-liner
Plastic Pump



NO STUFFING BOX—Elimination of stuffing boxes, packing glands and shaft seals, avoids the possibility of external leakage and prevents contamination of the transferred liquid by oil or grease.

SELF PRIMING—Vanton self priming plastic pumps give immediate operation in any position.

GET THE FACTS—Write for bulletin "VP" and the full story of Vanton plastic pumps

OUR CORROSION RESISTANT PRODUCTS FOR FLUID HANDLING include a complete line of Buna N and Natural Hard Rubber centrifugal pumps, valves, pipe and fittings. Bulletin BHR on request.

vpe

VANTON
PUMP & EQUIPMENT CORP.
EMPIRE STATE BUILDING • NEW YORK 1, N. Y.

NOTED AND QUOTED

(Continued from page 12)

How Many Trained Engineers in Russia?

After the war [World War II] the numbers of engineering graduates rapidly increased to about 29,000 from all Russian schools in 1948, to 30,000 or more in 1951, to probably about 40,000 in 1953, and to over 50,000 in 1954, according to late indications. This may be compared to about 19,000 from engineering curricula, unaccredited as well as accredited, in American colleges and universities in 1954. It seems probable that the total number of trained engineers in Russia today is closely comparable to the number in the United States.

M. H. Trytten
National Research Council

Ten Commandments for Technical Men

1. Thou shalt not follow in the dust of progressing operations, but shalt run ahead with a lantern in thy hand to reveal the way.

2. Thou shalt seek and respect the opinion of operators, even unto the third helpers, for theirs is a wisdom unknown to technicrats.

3. Thou shalt determine what shall be done and do it, without the necessity of others holding thy hand.

4. Thou shalt not be too dignified to shoot the bull; neither shalt thou shoot it entirely, for so is its productivity destroyed.

5. Thou shalt not forsake the ways of thy technical training, so that to thee CH_2O cease to be formaldehyde and become sea water.

6. Thou shalt not take thy grievances and ideas first to the top, lest the bottom remove its supports from under thee, saying, "We knew nothing of it."

7. Thou shalt remember that refining processes change not because of reasoning and meditation, however profound, but only by the turning of valves.

8. Thou shalt study the conclusions from all sides through many viewpoints, for verily, undiscovered claws may rip thy rear.

9. Thou shalt strive to make thy judgment as good as any man's by experimenting, observing, recording, calculating, studying, and thinking; and having done so,

10. Thou shalt use it.

A.I.Ch.E. Student Chapter News

∫ This list was passed around periodically at Esso. The author remains unknown. [Editor]

Louisville Method

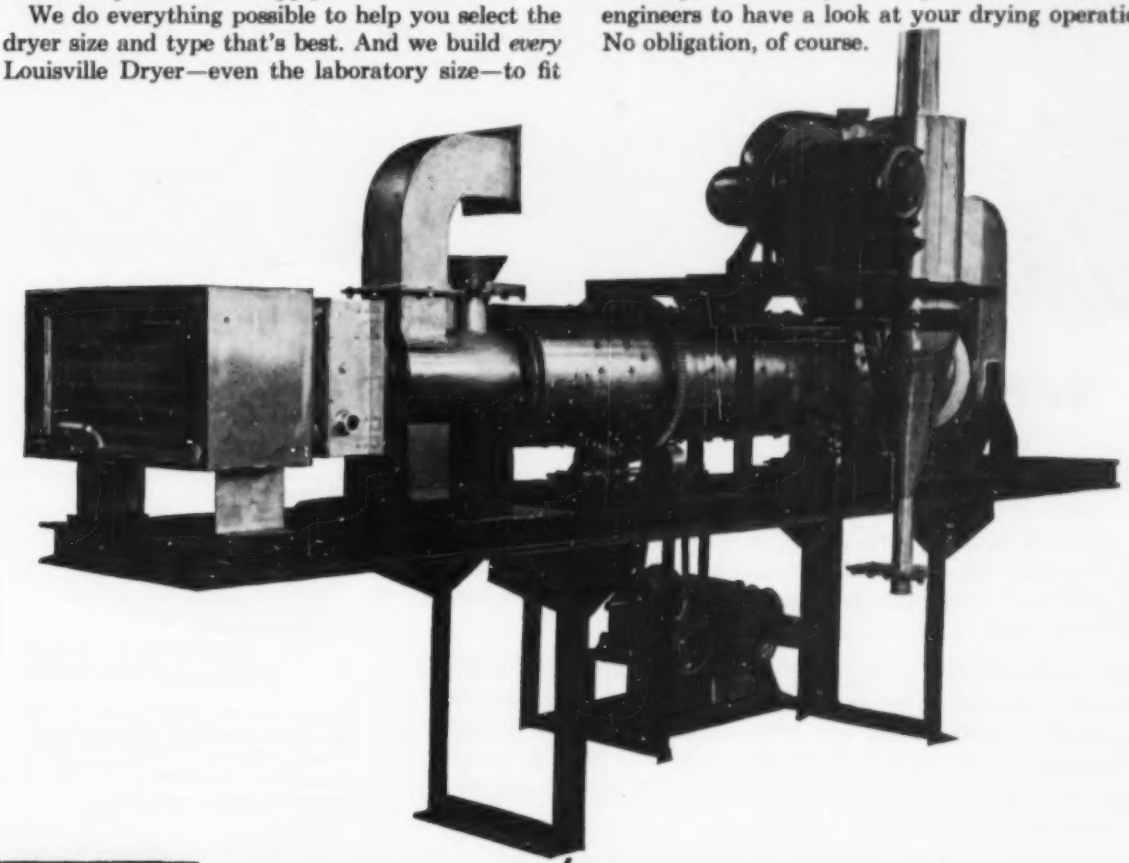
how **BIG** should a dryer be?

"Baby" Louisville Dryers do a man-sized production job for chemical firm

A large chemical firm has twice bought small, laboratory-size Louisville Dryers to serve as pilot plants for new materials. In both cases, their engineers were amazed to find the pilot dryers were producing sufficient quantities to supply the market!

We do everything possible to help you select the dryer size and type that's best. And we build *every* Louisville Dryer—even the laboratory size—to fit the job, and to give years of satisfactory performance at rock-bottom maintenance cost.

Let Louisville's 53 years of drying experience, spanning thousands of installations for all types of industry, work for you. Why not ask one of our engineers to have a look at your drying operation? No obligation, of course.



PROCESS EQUIPMENT DIVISION GENERAL AMERICAN TRADE MARK

LOUISVILLE DRYING MACHINERY UNIT
over 50 years of creative drying engineering

GENERAL AMERICAN TRANSPORTATION CORPORATION
Dryer Sales Offices: 139 South Fourth Street, Louisville 2, Kentucky
General Offices: 135 South LaSalle Street, Chicago 90, Illinois
In Canada: Canadian Locomotive Company, Ltd., Kingston, Ontario
OFFICES IN ALL PRINCIPAL CITIES
Other General American Equipment: Turbo-Mixers • Dewaterers Towers • Tanks • Pressure Vessels

For dependability see General American—creative engineering, design, construction, installation



when you're out for bear . . .

. . . don't be under-gunned. If you're out for grizzly or Kodiak you can't do better than a .375 Magnum, and you'll probably use a scope. If you're hunting smaller bear you'll get along well with a lighter-powered 30-06.

There is no need ever to be "under-gunned" in centrifugal processing. Sharples, with a complete line of 7 different types of centrifuges makes it possible to select the one right centrifuge for a particular application —whether for the separation of two immiscible liquids, controlled removal of solids from a slurry, dehydration of crystals, clarification of a liquid or concentration of a solid.

Your assurance of an unbiased recommendation is based on this complete line of Sharples centrifuges—each developed for peak performance in its range of application. You can depend on Sharples.



CENTRIFUGAL FORCE HARNESSED FOR WORK

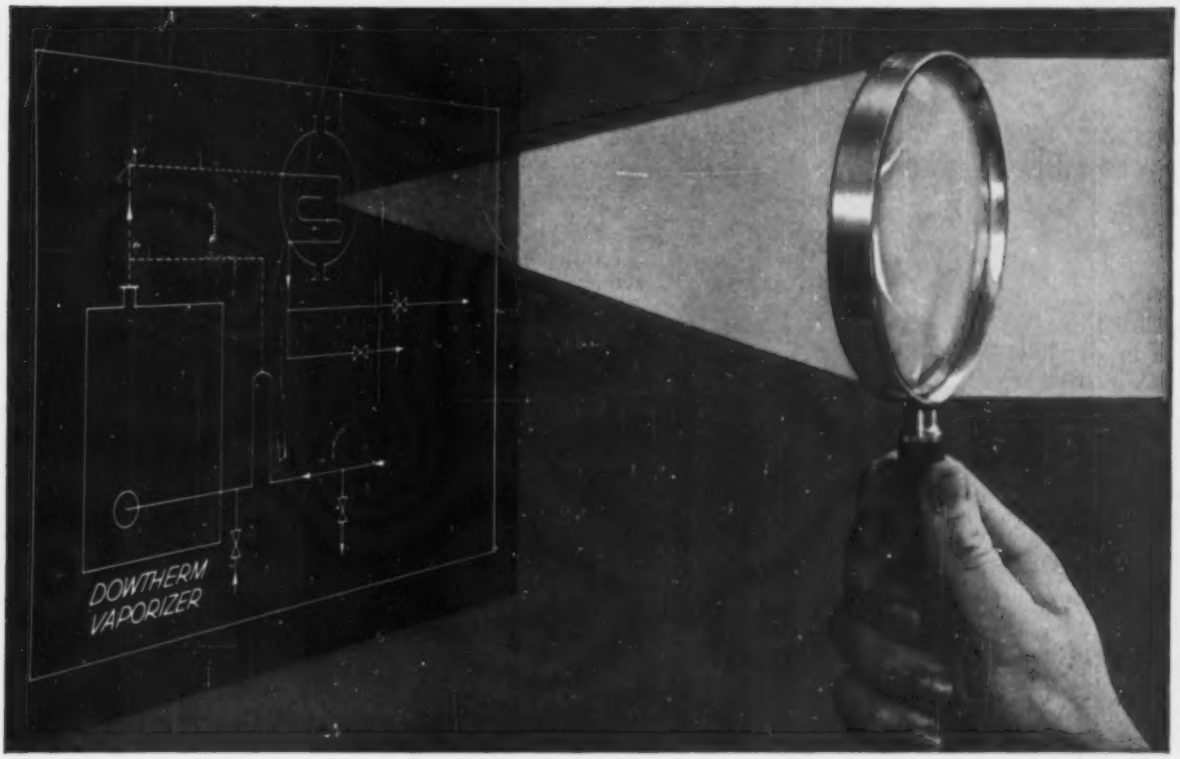
Sharples Bulletin 1259 describes in concise pictorial form all of the basic types of centrifuges and discusses factually the performance characteristics of each. A copy will be sent at your request.

And in addition . . .

Would rapid, accurate particle size distribution analysis help in your production control or research? Investigate the Micromerograph described in Sharples Bulletin 101.

SHARPLES

THE SHARPLES CORPORATION
2300 WESTMORELAND STREET • PHILADELPHIA 40, PENNSYLVANIA
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PRECISION CONTROLLED HEAT

...within fractions of a degree at temperatures up to 750°F... can be maintained with DOWTHERM

Precision control of process heat has become routine in the many process industries now using Dowtherm®. This modern heat transfer medium maintains temperatures within a fraction of a degree by simple pressure regulation—does it uniformly over the entire heating surface, too. This points the way to increasing your production without the danger of hot spots or overheating.

A liquid material used as a vapor heating medium in an entirely closed system, Dowtherm operates at *high temperature*, *low pressure*, and extends the advantages of steam-type heating to a much higher range of temperatures. Many process industries have taken advantage of these properties to develop new products—or improve old products through better production control.

Since Dowtherm does not contain any minerals, there are no costly scaling problems in your vaporizer or processing equipment . . . only a minimum of maintenance is required.

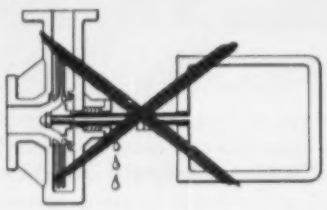
This really modern heating medium could well be your "edge" in highly competitive markets of the future. For complete information—the what, the why and the how of Dowtherm—write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. DO-876A-2.

you can depend on DOW CHEMICALS

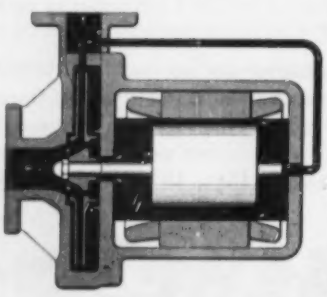
"CANNED ROTOR" PUMPS PAY OFF IN LOW UPKEEP COSTS, NO FLUID LOSSES

UNIQUE CHEMPUMP DESIGN SAVES TRICHLORETHYLENE USER $45 A DAY

Philadelphia, Pa. Officials of a large electrical switchgear manufacturer recently stated that $45 per day savings of trichlorethylene resulted from installing a Model CF Chempump on a distillation-type degreaser. Fluid losses with the ordinary centrifugal previously installed averaged 25 gallons a day. "On top of this," they stated, "we had to repack the pump every two days. We'd tried all kinds of packing, some of them very expensive—but without luck. Since installing the Chempump, we haven't lost a drop of solvent, and there has been absolutely no maintenance."



Design secret of the Chempump lies in combined construction of pump and motor, which eliminates seals, stuffing boxes, lubrication, long external shafts, etc. The Chempump allows pumped fluid to enter rotor chamber; a corrosion resistant liner isolates stator windings. Chempumps are available in sizes from ⅛ to 7½ horsepower, and in a wide variety of construction materials.



NUCLEAR SERVICE REQUIREMENTS SPUR LEAK-PROOF PUMP PRODUCTION

Less than two years ago, only one company in the country was producing and marketing a canned-rotor pump. Today, spurred on by the atomic energy program, half a dozen firms are at work on models for atomic-powered submarines, nuclear energy central stations, even atomic-powered aircraft.

To the man in the chemical process industries, all this is good news, because canned-rotor pumps can't leak. They require no shaft seals or stuffing boxes, maintenance is practically nonexistent. And leakage losses, high maintenance costs are two of the biggest headaches centrifugal pump users face.



H. T. White and D. P. Litzenberg (left), developers of the first practical seal-less "canned-rotor" pump. On the desk are plans for an extreme-pressure, extreme-temperature design.

Canned-rotor pumps came about through the efforts of two young Philadelphia engineers, now officers and directors of the Chempump Corporation. Working on principles developed before World War II, they did further research and engineering, and in 1947 began production of a seal-less, canned-rotor pump.

Even while tooling up for production of this first model, the two designers were planning variations for specific applications in the chemical process industries. Pumps were built to handle extreme temperatures and pressures as well as a variety of corrosive fluids. The pumping requirements of chemical processors were carefully studied, and steps taken toward standardization of designs to meet those requirements.

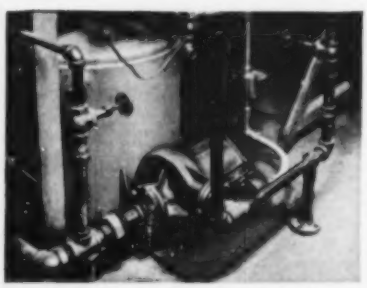
1952 saw the formation of the Chempump Corporation to build canned pumps for the chemical process industries. Experience gained from nearly 15 years of laboratory and field testing went into the design and production of products offered by this corporation. First in the field of canned-rotor pumps, Chempump is also first with pumps tailored specifically to the chemical processing industry.

PUMP SERVICE POLICY ENDS MAINTENANCE PROBLEMS

To reduce process downtime, many plants purchase a spare pump for every two, three, or five pumps installed, depending on circumstances. We feel this is a good policy, since downtime is limited to the time required to install a spare.

But what about repairing the faulty pump? Are proper spare parts on hand? How about maintenance department scheduling? The answer to these and other problems is the Chempump Service Policy. Any Chempump, damaged or inoperative for any reason—including improper pump application—will be repaired at the factory and returned to the customer with a new pump warranty. The pump is completely rebuilt, inspected and tested by factory experts . . . and the cost is moderate.

This service policy stops repair headaches, cuts spare parts inventory, and in effect, places a new pump on your shelves in short order.



Chempump handling condensate under extreme vacuum for large Eastern chemical manufacturer. Air contamination would render system inoperative.

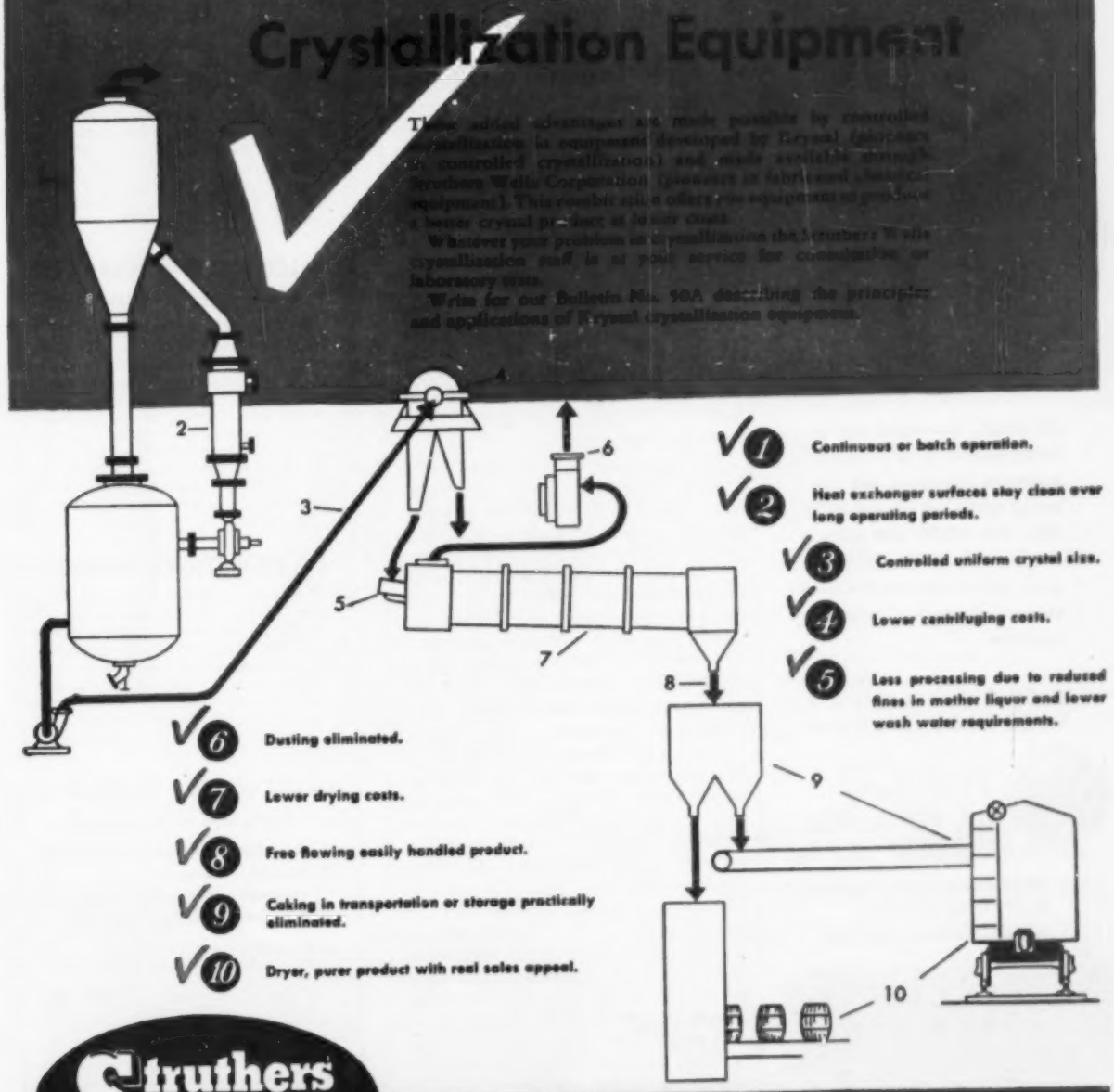
Chempump First in the Field

CHEMPUMP CORPORATION
1379 EAST MERMAID LANE • PHILADELPHIA 18, PA.

check these added advantages of

Struthers Wells KRYSTAL

Crystallization Equipment



✓1 Continuous or batch operation.

✓2 Heat exchanger surfaces stay clean over long operating periods.

✓3 Controlled uniform crystal size.

✓4 Lower centrifuging costs.

✓5 Less processing due to reduced fines in mother liquor and lower wash water requirements.

✓6 Dusting eliminated.

✓7 Lower drying costs.

✓8 Free flowing easily handled product.

✓9 Caking in transportation or storage practically eliminated.

✓10 Dryer, purer product with real sales appeal.

Struthers Wells

STRUTHERS WELLS CORPORATION WARREN, PA.

Plants at WARREN, PA. and TITUSVILLE, PA.

OFFICES IN PRINCIPAL CITIES

for *Low*
VACUUM PUMP MAINTENANCE COSTS and BETTER VACUUM . . .
it's the
HILCO OIL RECLAIMER
VACUUM for PUMP USERS . .

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MARGINAL NOTES

How to Sell Chemicals

Successful Commercial Chemical Development. Edited by H. M. Carley. Sponsored by the Commercial Chemical Development Association. John Wiley & Sons, Inc., New York, N. Y. (1954), 362 pp. $7.75.

Reviewed by Carl Setterstrom, Chas. Pfizer & Co., Inc., Brooklyn, N. Y.

The chemical engineer interested in the development and sale of chemicals will find this book a good investment. Since only about half of the subject matter is likely to be of special interest to him, he should begin his reading with Chapter 10, "New Product Objectives Preceding the Process Development and Semi-works stages."

This excellent chapter contains a useful check list, indicating the relative importance of the various sales and production factors. This list is worth the time it takes to decipher as it is carried over into the following three chapters which discuss new product project objectives in the process-development stage, the semi-works stage, and while awaiting full-scale production.

The remaining eight chapters are of general interest but uneven in quality. The chapter on case histories is among the best because it conveys something of the challenge and risk of new-product development. It should be good reading for production men who like to second-guess the sales department. Chapters on advertising, retail problems, and sampling are of interest for newcomers in these fields. Unfortunately the chapter on pricing omits explanation of important pricing influences.

The earlier chapters of the book are less interesting and may be confusing to those who are not closely associated with product development. The confusion arises from attempts to define, describe, and circumscribe the many overlapping groups and skills used in commercial chemical development. As stated in Chapter 7, "The best plan of organization to achieve the most effective simultaneous development of a number of new products is not easy to delineate," especially when the new products are as diverse as allethrin, nylon, and shoe polish. And organization charts reflect weaknesses and strengths of the men who make up the organization.

Nevertheless, all who played a part in getting this book out have earned the gratitude of our industry and profession.

(*More Marginal Notes on page* 30)

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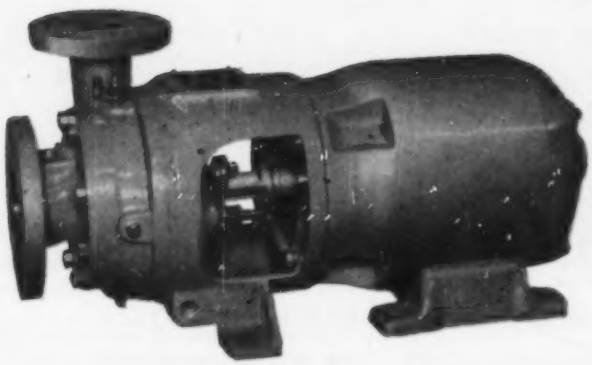
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MARGINAL NOTES

(Continued from page 28)

For the Sales Engineer

Modern Chemical Processes, Vol. III. Editors *Industrial & Engineering Chemistry*. Reinhold Publishing Corp., New York (1954), 276 pp. $5.00.

Reviewed by J. W. Hemphill, Johns-Manville Sales Corp., New York.

This volume follows the same general pattern that was used in Vol. I and II. The twenty-three American chemical processes covered in this volume show the usual wide diversification of process subject. The engineering articles are technical case histories of the various processes and contain the following essential details.

Commercial and technical history and origin of the present installation.

Plant installation data, including details of nonstandard equipment.

Description of process and operating practices.

Economics of process, including raw materials, cost breakdown, and plant investments.

Future prospects, including improvements and changes that could affect the industrial application of the process.

The articles have been written at a level of knowledge that is certainly technically informative but not at the intensive knowledge level that would permit process design. On this basis they have value to the industrial chemist, the chemical and mechanical engineers and advanced students in these fields. It is the writer's opinion that they have even greater value to those who have the job of furnishing equipment, building process plants and subsequently serving them. Although the technically trained engineer salesman is a "must" in contacting the process industries, it is neither possible nor desirable to make a specialist out of him. As stated above, these articles as case histories have the background of engineering process data and materials of construction information that can be of assistance to the suppliers of equipment and services, and to the sales engineer who is desirous of doing an intelligent job of servicing the process industries.

These articles appeared in *Industrial and Engineering Chemistry*, but as published in book form their value has been emphasized and they are brought to the attention of a greater field of useful readership. The cost is nominal and well in the range of practically everyone's pocketbook.

As case histories of modern processes, this volume is recommended.

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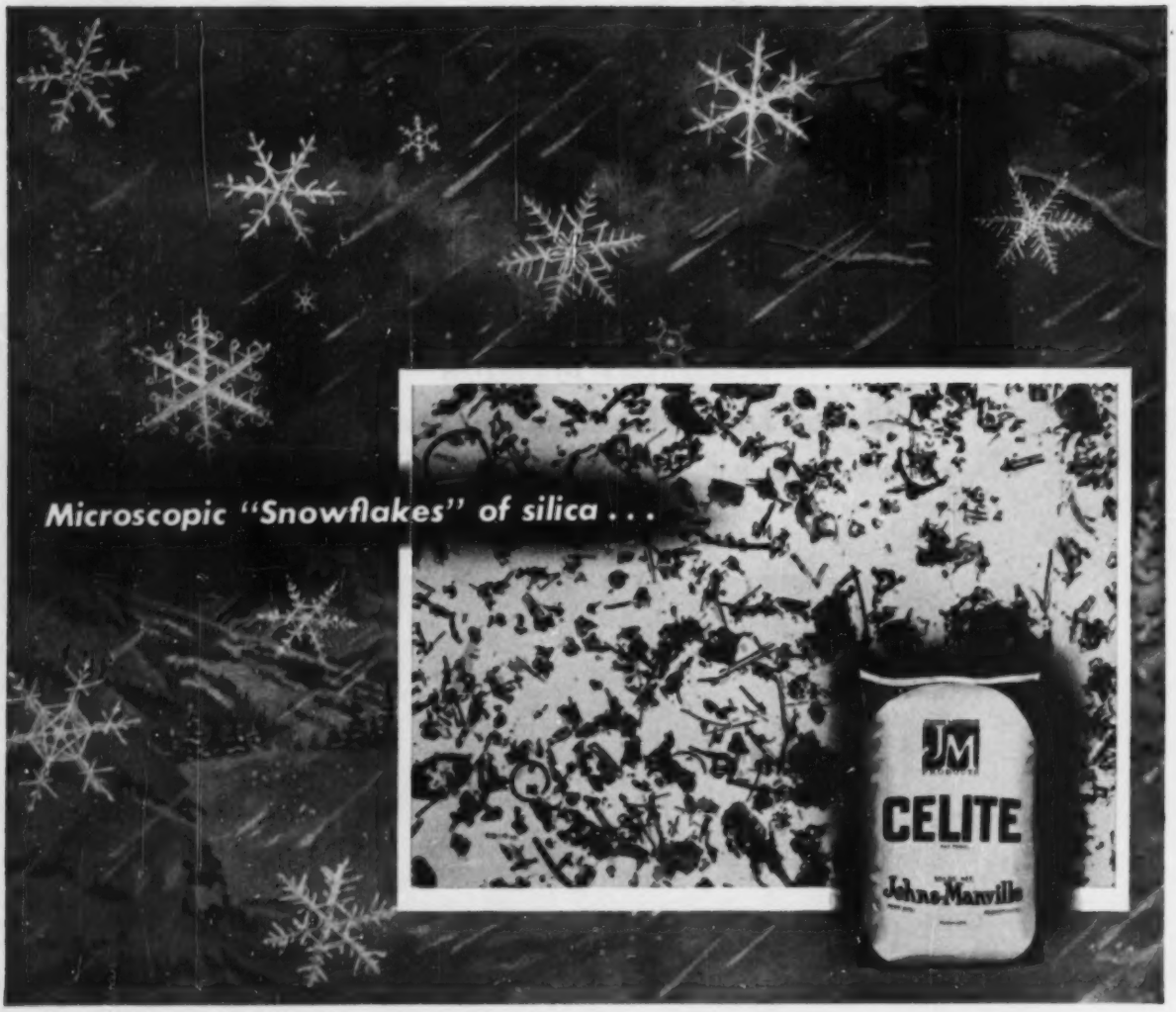
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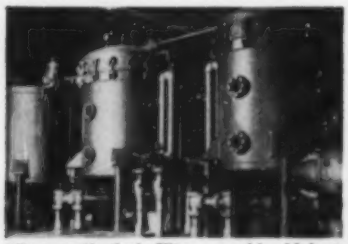
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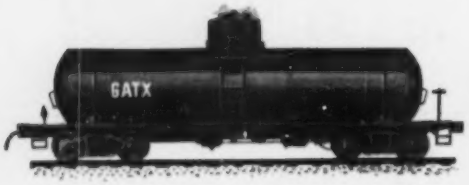


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Cooperation Among Engineers

One of the heartening signs of maturity in the engineering profession is the steadily increasing examples of cooperation between the various kinds of engineers. Looking at the past history of engineering, one is tempted to predict that we have reached a point in our history when the divisive forces are waning, and we are starting the long journey to an over-all, single basic engineering degree, profession and ethic. Not that this means return to a single technique, as once engineering was in its early beginnings. Then it was simply military engineering or civil engineering and from this have come the major divisions in the field—Civil, Mechanical, Electrical, Mining and Metallurgical, and Chemical. Rather the consolidation will occur at some future time when the underlying principles of engineering are so well understood, and so common to all fields, that the present major divisions will be specialties studied in extra years of college for advanced degrees. That day, though, is far off and in the meantime unity in the profession gathers momentum through various agencies.

One of these agencies, namely E.C.P.D., which stands for Engineers Council for Professional Development, had a meeting in Cincinnati during the last week of October, and all the Societies, A.I.Ch.E. included, reported on many encouraging examples of unification. Our recent constitutional changes have given us uniform membership grades with the Mechanical Engineers and the Electrical Engineers. The theme of the meeting was "A Community Project in Professional Development," and in this issue Raphael Katzen tells of the part a local section of the A.I.Ch.E. played in an important new means of helping all engineers to a better professional life. The accrediting of engineering colleges by E.C.P.D. is so well known that it is taken for granted, but in Cincinnati the Education Committee again, as every year, presented its lists of approved curricula. It is a point of pride with us that accreditation was begun in 1922 by A.I.Ch.E. with chemical engineering courses. Later, in 1932, the other societies, through E.C.P.D., began similar activities.

This is not the only agency for cooperation, though, for E.J.C., or Engineers' Joint Council, is also an intersociety effort. Examples of cooperation through this agency are numerous. The committees of the Engineering Manpower Commission which seek to impress on the Selective Service organization the need, functions, and usefulness of engineers have studied and reported on the economic status of the engineers, the nation's water policy, the Atomic Energy Act, and the effect of social security laws on engineers. Several important explorations are even now under way, one a cooperative congress in nuclear engineering.

In guidance, student development, recognition of the profession, yes, and even in ethics, uniform practices and codes are being slowly and tediously worked out. All such actions, though seemingly minor indications of a trend, are nevertheless important if only to help the profession habitually to think of cooperation in common problems. Who knows where it will lead, or what giants of tradition, indifference, ignorance, and even law, will topple before it.

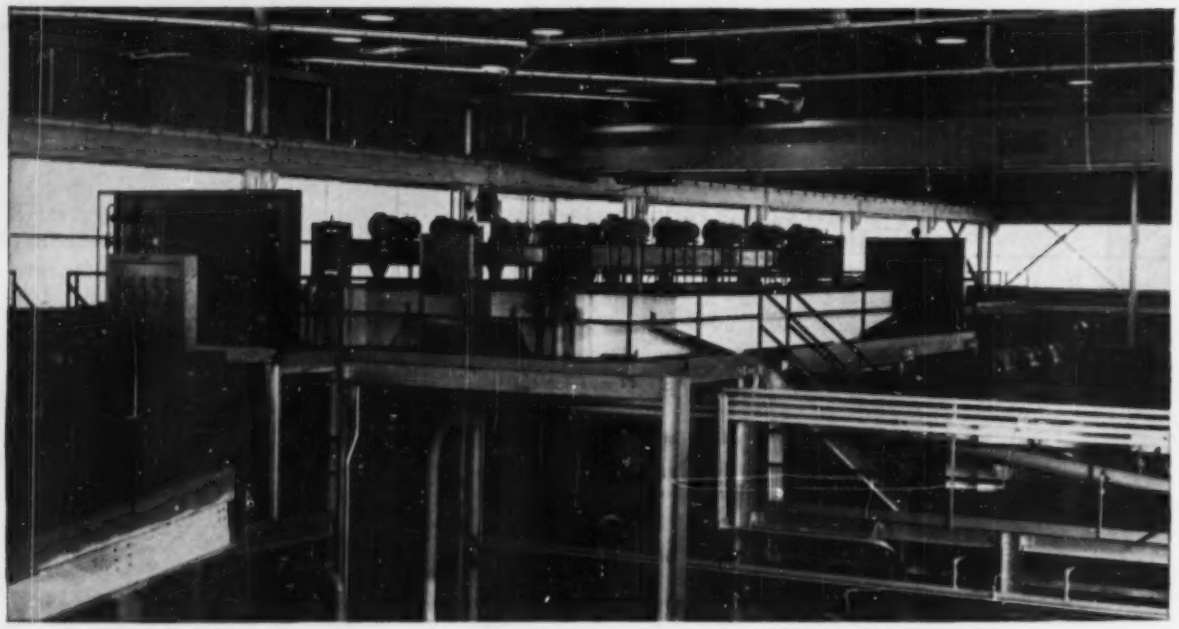
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what management expects from a young chemical engineer

Reported by *W. R. Manning*

Project engineer, Carbide and Carbon Chemicals Co., Member, Professional Development Comm., A.I.Ch.E.



Charleston Panel *

The Professional Development Committee believes that meetings of this character aid in acquainting the young engineer with what is expected of him, and recommends to other sections of the Institute that they consider putting on meetings of this type. An attractive feature is that no out-of-town speakers are required. Judging from the experience in Charleston, an enthusiastic audience is assured.

—Editor

Many young engineers, particularly those just out of college and in their first jobs, desire definite ideas of what management expects of them beyond the mechanics of doing the immediate task to which they are assigned. They fear they may miss opportunities to develop their capabilities and their personalities in directions which could result in their professional advancement to positions of more responsibility. In an effort to satisfy this desire, the Charleston, West Virginia Section, A.I.Ch.E., presented at one of its monthly meetings a panel discussion on the subject "What Management Expects of a Young Chemical Engineer." The panel was made up of seven management representatives from several chemical companies having plants located near Charleston, with a moderator who is also a member of management. Each panel member was asked to prepare a short talk outlining his ideas, based on his own experience. These talks were followed by a question-and-answer session in which questions from the floor were answered by the panel.

* *The panel consisted of the following seven representatives of management from chemical companies located near Charleston:*

F. A. Otto, *plant manager, Belle Works, Du Pont Co.*

W. Q. Smith, *manager, technical section, Belle Works, Du Pont Co.*

C. H. Atwood, *sup't, Institute plant, Carbide and Carbon Chemicals Co.*

J. A. Mooney, *manager, South Charleston plant, Westvaco Chlor-Alkali division, Food Machinery and Chemical Corp.*

J. Cresce, *manager, Nitro plant, Monsanto Chemical Co.*

K. H. Rowland, *general sup't. South Charleston plant, Carbide and Carbon Chemicals Co.*

W. S. Brackett, *vice-president, Carbide and Carbon Chemicals Co.*

Moderator, S. W. Pickering, II, *manager, general industrial relations department, Carbide and Carbon Chemicals Co.*

Otto—*A selling job by management and by new employees*——Reviewed the usual process by which a new engineer is hired. In general both management and the prospective employee have selling jobs to do. Management, if it likes the looks of the prospective employee, tries to convince him that the company is a good one for which to work, and the prospect has a good chance for a happy future with the company. The candidate in turn has the job of convincing management that he is a worthy prospect and that he should be given the opportunity to prove it.

Noted that the period immediately after a new engineer comes to work is quite critical. It is important that the new employee get a good start, and this is a serious responsibility of management. Likewise, it is up to the new engineer to adjust himself rapidly to his new job and to life in the particular community in which he lives. Management expects a man to show enthusiasm, a desire to learn, and an interest in his assignments and in his company. After the initial period of transition from college to a job, management anticipates that a man will grow with his job. It is management's duty to maintain regular contact with a man—to see how he is progressing and to let him know how he is doing. To do this requires a minimum of one interview every six months between the man and his immediate supervisor or someone higher. Mentioned the importance of agreeable personality and adaptability to changing situations.

Smith—*Technical competence and personal qualities*——The engineer has a selling job to do, not only in getting his first job, but in holding down jobs throughout his career. Management also looks for enthusiasm and energy, and an eagerness to take constructive criticism gracefully and gratefully and profit by it. Fundamentally the engineer has to develop himself, especially in technical competence, but also in social facility and poise.

Atwood—*Engineer—happy but never satisfied*——The job an engineer faces in selling himself to management is no different from selling any other product. The product must be as good as or better than any other product available. An engineer can improve himself, both in technical competence and in personal qualities if he is really interested in doing so. An engineer should consider his job as a hobby; he should not have chosen engineering if he were interested only in making money. An engineer must be happy, but must never be satisfied. He should have imagination and a good idea of what he hopes to accomplish, and should be able to capitalize on whatever breaks he gets. Above all, he should keep his immediate supervisor informed and satisfied.

Mooney—*Cooperativeness, enthusiasm, loyalty*——Perhaps technical proficiency is stressed too much by the engineer; he should pay more attention to exhibiting other qualities, such as enthusiasm, aggressiveness, curiosity, friendliness and cooperativeness, group loyalty, and company loyalty. Community activity is also important. The part a man's wife should play in the company's evaluation of him is an unsettled question which is being widely discussed at present. A good answer to this question should be developed. A knowledge of human relations is just as important to an engineer's success as technical ability.

Cresce—*Mental flexibility*——Be able to accept criticism and capitalize on it. Industry is constantly undergoing change, and for this reason mental flexibility is important. The engineer must show management that he is not only willing to adapt himself to changing situations, but also capable of doing this.

Rowland—*Meeting a problem head-on*——The primary reason for the existence of industry is to make profits. Therefore, a really successful engineer in industry is one who can meet a problem head-on and come up with a quick solution which is practical, economical, and salable. This requires energy. It sometimes means doing the "impossible." And it sometimes means running counter to another's wishes and desires. This latter must not happen too often, however, because management cannot afford to spend its time smoothing over difficulties created by proposals from engineers.

Brackett—*What it takes*——Without the homely virtues no engineer can hope to have a successful and satisfying life. Mr. Brackett's remarks are reproduced on the opposite page.



After the prepared talks had been completed, a question-and-answer session was held, in which questions from the floor were directed to the members of the panel. Several questions concerning salaries of engineers were asked, but in accordance with a previously arranged plan, those asking such questions were referred to the recent A.I.Ch.E. questionnaire. Other questions, with the answers supplied by the members of the panel, were as follows:

Discussion

Question: What sort of community activities would engineers be expected not to engage in?

J. Cresce: In general, management encourages most kinds of outside community activities, including politics, church work, and other related activities.

Question: What is management's position on planned programs for development of engineers?

K. H. Rowland: In my opinion, the value of planned programs is questionable. It is up to engineers to develop and to sell themselves as individuals. Management hopes that engineers are smart enough to grow in any kind of system.

Question: Does management expect engineers to become members of technical organizations such as A.I.Ch.E.?

W. Q. Smith: Management expects an engineer to keep up with developments in his field; and management has a duty to encourage an organization such as A.I.Ch.E., which is publishing technical information.

C. H. Atwood: Management should not require that an engineer or anyone else belong to any organization to which he does not choose to belong.

Question: What about people who are not executive people?

J. Cresce: In modern industry there is room for every type of person. Nonexecutives should receive the same compensation and recognition as those in executive positions.

Mr. Brackett's remarks covered the general subject so broadly, that he was asked to prepare a condensation which is presented below.—Ed.

brackett



William S. Brackett

Carbide and Carbon Chemicals Company
South Charleston, West Virginia



on "what it takes"

Under our American economic system all industry is forced by competition to operate as efficiently as possible. Efficient operation depends on the proper utilization of men, material, and capital, none of which can be accomplished without having the right people on the right job at the right time. Thus, selection of people (employees), by people (management), for people (owners or stockholders), is a primary concern of management. Though this is generally true in all businesses, it is particularly true in the chemical industry. The chemical industry is young, and is growing at a rapid rate. In order to keep pace, management must utilize technical personnel to the best advantage.

Today technical work—research, operations, engineering, sales—is done by

teams, and management recognizes that it takes men with varying technical competence, and with different personal characteristics to make up the teams. Young engineers customarily start in technical jobs associated with their educational background. As time goes by, management evaluates not only the technical competence, but also the personality of young engineers, and moves them around in order to use those characteristics to their, and the company's, best interest. Ultimately, the engineer (who may no longer be young) finds himself in his proper niche, which may be a technical or a nontechnical job—having to do directly with engineering or not—depending pretty much on what sort of a person he is. He will have demonstrated the extent of his ability to handle the technical aspects of the work. He will also have shown that extra something which gives his bosses confidence that he will handle successfully his responsibilities—that he can be counted on to do the right thing; on a technical job, to come up with the right answers; on an executive job, to get the right response from his subordinates and to judge the quality of their work—in either case, to maintain correct relationships with whomever he may come in contact.

President William Howard Taft in 1912 in a speech to Vermonters in Vermont quoted his father as saying, "The Vermonter was a safe man, upon whom you could count for the things he ought to do, and he never failed." I think that applies equally well to being a engineer, or a salesman, or a production man, or a researcher, or an industrial relations man. Many, many times in discussing the choice of men for responsible jobs, one hears the expression "So-and-so can do it. He is solid as a rock. You can count on him." Or, "I'm never quite sure how so-and-so will react." There is never any question on the choice made.

Certainly in an industry as complex as the chemical industry, it is reasonable to expect technical competence from technical men working on technical jobs. That seems to be axiomatic. Technical competence is controllable within limits by every individual. It is the superimposition on a man's own intellectual capacity of the quantity and quality of the knowledge he acquires by study and experience. It seems equally self-evident that the extent of the need of technical competence must vary from job to job and from department to department, and that, since the degree and scope vary with the job, *you can't have too much but you can have too little.*

Much has been written and much has been said about what modern management looks for in placing technical personnel. Aside from the necessary scientific and engineering "know-how" that has been introduced by the complexity of modern industry, management today is looking for exactly the same qualities that people on responsible jobs have looked for in their associates since time began—what our forefathers called the "homely virtues"—what, in modern parlance, is known as "what it takes." These qualities are: honesty, loyalty, industry, capability, judgment, self-reliance, self-respect, poise, and personality. It would be difficult to find any two people who would assign the same relative importance to these qualities, with the single exception of honesty.

Honesty

Every thinking person would rate honesty above the others—honesty, not solely in the ethical sense, but also in the sense of doing a full day's work; of making a real effort to solve a problem; of digging out the basic information and, from it, working through a careful analysis to a logical conclusion. Honesty includes admitting a mistake—saying, "I don't know, but I'll find out"—and then finding out. Honesty means giving the other fellow credit where it is due—not stealing his ideas and foisting them off as one's own. Management takes a dim view of idea-pirating not only because of the ethics involved, but also because it makes for poor teamwork.

Loyalty

Loyalty—to yourself, your family, your department, your company—is a must. You certainly cannot expect your associates to cooperate with you if they can't count on you to *stand up for them.* How can management be expected to pick an employee for a better job, if it does not believe he will stay with it?

Industry

Industry means more than doing a day's work in a day's time. It means doing more than *exactly* what the boss asked for. It includes alertness and curiosity—to the extent of not only doing one's own job but also finding out what else goes on around one. It includes ambition: not merely the desire for success, but the willingness to work for it.

Capability

Capability means the ability to get results. Management wants men who get things done. But that in itself is not enough. Results sometimes do not speak for themselves. It is necessary to include articulateness with capability—the ability to communicate ideas to others effectively and economically of words.

Judgment

It is hard to improve on the dictionary definition of judgment:

The power of arriving at a wise decision or conclusion on the basis of indications and probabilities, when the facts are not clearly ascertained.

All too frequently in the chemical business the "facts are not clearly ascertained," and it is necessary to rely on judgment. Stemming from knowledge, experience, discretion, and discernment, judgment can be cultivated and, in fact, must be cultivated if one is to progress.

Self-Reliance

Self-reliance does not mean relying on oneself to the exclusion of working with and cooperating with others. As mentioned before, technical work is accomplished mostly by teams. There is little room for solo performances. Self-reliance includes self-confidence, the willingness to accept responsibility, to admit mistakes, the willingness to go ahead without too frequent consultation with the boss— but, at the same time, recognizing that he must be kept generally informed.

Self-Respect

Self-respect is precisely what the words say—respect of one's self as a person. It shows itself in how one stands, looks, talks, acts, dresses. It is never evinced by arrogance or a me-first, know-it-all attitude. It breeds tolerance and respect for the other fellow.

Poise

Poise means balance. It does not mean apathy or supineness. And it does not preclude enthusiasm. It means emotional stability. It means the ability to argue without loss of temper, to win without gloating. It means, above all, composure in the face of provocation.

Personality

Personality is an all-inclusive term, covering the "virtues" touched on above, as well as agreeableness, courtesy, dignity, personableness, a sense of humor. Personality is a characteristic that is an asset on every job, in the home, and in the community. Management recognizes that a satisfying life away from the job is a strong asset on the job, that the one seldom occurs without the other.

Excerpts from a talk at an A.I.Ch.E. Charleston, West Virginia, Section.

The Professional Development Committee of the Institute recommends study of the following report by the local section, as a source of ideas useful in planning similar activities.—*Editor.*

professional development activities in cincinnati | a pilot study

Raphael Katzen *
and Cornelius Wandmacher **



Cincinnati—in the industrial heartland of the United States—is the scene of a professional development program of importance to engineers throughout the country. As a community with widely diversified industrial operations, and a long history of cooperation between industrial, educational, and engineering organizations, Cincinnati was selected by the Engineers' Council for Professional Development as the scene of a pilot study of its six-point program for the development of young graduate engineers.

Such a "community project" is intended primarily to determine effective means by which industry and the profession may provide a favorable climate for professional growth of the young man, and second, to determine how the young engineer may be made to realize that the final responsibility for professional advancement rests with him, the individual.

The basic foundation of this program lies in tripartite cooperation between the community's educational institutions, industries, and engineering societies. Actual organization and promotion of the new program are carried out by the Professional Training Committee of the E.C.P.D.—a conference of A.I.Ch.E., A.S.C.E., A.I.M.E., A.S.M.E., A.I.E.E., the Engineering Institute of Canada, the American Society for Engineering Education, and the National Council of State Boards of Engineering Examiners. A review of earlier development of professional activities in Cincinnati will facilitate comprehension of the cooperative nature of the program being developed.

* Consulting Engineer, Member, Professional Development Committee—A.I.Ch.E.
** Head, Department of Civil Engineering, University of Cincinnati, Chairman, Professional Training Committee, E.C.P.D.

Background of Local Engineering Activities

Nearly fifty years ago, Dean Herman Schneider of the College of Engineering of the University of Cincinnati, initiated the first cooperative program for education of engineering students. This acquainted local industry with the problems of engineering education, and developed an understanding of professional problems which has benefited local engineers immeasurably since that time. Perhaps the most concrete example of the enlightened industrial approach was the establishment in 1945 of the Herman Schneider Foundation by local industry (over 90 corporations participating) which financed and made available to local engineering societies a fine headquarters and meeting place, including library and dining facilities.

Actual administration of the headquarters is carried out by the Engineering Society of Cincinnati, a professional-social organization with some 1700 members. ESC also shares these facilities with over 5000 members of the local sections of 25 national engineering and scientific societies under a joint membership plan. Before one of these local sections may use the facilities of the headquarters building, 15% of its members must belong to the ESC. The Ohio Valley Section of the A.I.Ch.E. tops the joint membership list, with more than 50% of the section members belonging to the ESC.

Professional Development activities have been promoted in this community for many years by the ESC through its Professional Development Committees. Last year 133 members of its seven subcommittees participated in the following programs: Education, Professional Activities, Library, Vocational Guidance, Science Awards, Legislation and Historical. This is a very broad-gauge program, ranging in interests from those of high-school juniors to those of the mature, experienced engineer. As an adjunct to this program, the ESC sponsors an annual "Newcomers Night," usually in November, to acquaint all engineers who are newly arrived in the community, including the young graduates, with local activities.

Although the work described above is carried out by members of ESC, and as noted, not all members of local sections of national societies are members of ESC, cooperation and coordination of activities are provided by the Technical and Scientific Societies Council, which consists of two representatives from each professional society and the ESC. The Council not only organizes the use of the headquarters facilities, but also sponsors a Joint Annual Meeting, and an "Engineer of the Year" award. Forty issues of a weekly news bulletin, giving programs and activities of the various organizations, as well as articles of general interest to the engineers of the area, are mailed to all members of Council societies.

A Joint Meeting for Professional Development

This year, in order to further the effort to acquaint engineers with professional development activities, the four local sections of the national professional societies—AIChE, ASME, AIEE, and ASCE—and ESC held on February 4 a joint meeting, sponsored by the Ohio Valley section of AIChE. This included a panel discussion of the program for young graduate engineers being sponsored by ECPD. It is hoped and anticipated that such a joint meeting will become an annual affair—sponsored in rotation by the participating societies.

A description of the organization of the meeting may be helpful to other local sections of the Institute interested in promoting activities of this type, which have the hearty endorsement of the Professional Development Committee of the Institute.

First of all, liberal use was made of the large fund of information available through ECPD. Prior to the meeting a series of six articles was published weekly in the local Council publication —*The Engineer and Scientist.* These served to describe in some detail the philosophy behind the major points in a professional development program.

Next, all of the societies participating in the joint meeting publicized the activity in their prior meetings, and in announcements in *The Engineer and Scientist.*

A preliminary draft of the keynote speech was distributed to the eight discussion group leaders prior to the meeting to insure correlation of their discussions with the keynote address.

Several weeks prior to the meeting, these eight discussion groups were set up with five members each—one from each of the participating societies. Members of these groups prepared themselves for the organized discussions by reviewing ECPD literature, by preliminary meetings and phone calls.

At the February 4 meeting, attended by close to 200 engineers, the program was organized so that after the keynote address, those attending were split up to join the eight discussion groups, each in a separate room or area. As an example: in one such group discussion, each of the previously appointed group members gave a five-minute résumé of one of the main points of the ECPD program. Then the session was thrown open for general discussion. This discussion was extremely productive of suggestions and recommendations for further action to foster Professional Development.

After the group discussions, the general meeting was reconvened for a brief summary by several discussion group leaders of the recommendations made in their meetings. It was the consensus that the meeting had been very successful in presenting the objectives of a professional development program, and in obtaining recommendations for methods of implementing such a program in our area. It was also felt that we had not done too well attendancewise—particularly in getting out the younger engineers. *Next time* we will concentrate on that aspect—and it is encouraging that so many attending referred to the *next time.*

Results to Date

The current ECPD program stresses professional development during the first five years of the graduate engineers' career—the critical and formative period during which the individual's progress had usually been slow. Steps already taken in Cincinnati have shown that the latent possibilities can be developed quickly if there is a concerted effort. A list of the six basic points of the ECPD program, and a summary of what has been done to implement them follow.

1. ORIENTATION AND TRAINING IN INDUSTRY

Many large industrial organizations have, of course, been carrying on training programs of their own. The present endeavor is to encourage more medium-sized and small industries to consider specific orientation and training procedures. A survey of some sixty companies in the area is now underway with the assistance of the Cincinnati Industrial Institute. This will provide a summary and exchange of basic information about such plans.

A local committee comprising representatives of nine major companies which were selected as a nucleus has been cooperating with the ECPD committee.

An important point noted in the organization of such an industry committee is that much important assistance will come from top management, personnel, and industrial relations people who are not necessarily engineers but who do have an appreciation of the great value of engineering talent in their businesses. Industry is cooperating also in a census of engineering and scientific personnel in the area.

2. CONTINUED EDUCATION

Accredited engineering courses are offered by only one educational institution in this city, the University of Cincinnati. Through the stimulus of the ECPD—Local Committee activity, it has been possible for the University to offer a much-enlarged program of graduate courses with credit toward advanced degrees. These are being made available through the evening college so that they may be of service to practicing engineers seeking such educational opportunities. A part-time associated teaching staff from industry is also being developed to supplement the full-time staff on the campus. In the first year of this program, most courses offered were oversubscribed so that multiple sections had to be set up. Even so, some applicants had to be turned away. A total of 285 men were enrolled.

3. INTEGRATION INTO THE COMMUNITY

The long standing work of ESC supplies an excellent base for this program. Two activities in particular apply to this point.

The Public Affairs Committee is charged with the responsibility of keeping the membership informed on civic matters. Although this committee does not represent the Society officially in controversial community affairs, it does strive to keep the engineers abreast of current problems and thus better prepare them to participate in civic affairs.

The Sunday Afternoon Family programs of ESC which help the membership become acquainted on a broad personal basis have inestimable value for integrating young engineers into the community.

4. PROFESSIONAL REGISTRATION

This phase is already well advanced through local industry's interest in having engineers meet all legal requirements affecting their work. Over 80 per cent of the young engineering graduates of the community are annually taking the engineer-in-training examinations and are preparing for full professional registration. Review courses are given regularly by several departments of the University. The high standards of licensing in Ohio and the excellent chances for licensing in other states by reciprocity have been of great assistance in encouraging the young engineer to apply before graduation.

5. SELF-APPRAISAL

The February meeting of the ECPD local sections and ESC included a review of the most desirable personal characteristics necessary for success in engineering, as stated in a report of the same title published by ECPD. Use of a recommended personal appraisal form was also discussed.

6. SELECTED READING

Recommended lists of books in both technical and nontechnical fields are issued by ECPD. These are in the form of the *Reading List for Junior Engineers* which deals with books of the humanistic-social fields, and also the *Selected Bibliographies of Engineering Subjects*. The ESC Library and the Cincinnati Public Library cooperate to make available and to foster use of the recommended references.

Summary

The newly developing program of the Professional Development Committee of A.I.Ch.E. will best be promoted through the local sections. The committee, however, will serve to recommend and coordinate activities of the sections. Study of the Cincinnati program is recommended as an indication of what can be accomplished by a concerted local effort and by taking advantage of existing material.

professional development

ABSTRACTS

Conclusion of the abstracts of papers in "Collected Research Papers for Spring, 1954," Chemical Engineering Progress Symposium Series No. 10, Vol. 50 (1954). Nine papers were abstracted in the September issue, page 480.

Evaporation of Solids Into Laminar Air Streams

R. M. Butler and A. C. Plewes
Queen's University

A theoretical relation has been derived for the rate of evaporation of a solid material which forms the base of a flat duct through which air is moving in streamline flow. The equations for the diffusion of matter through dilute fluid streams may be written in a form identical with that of the equations for the conduction of heat within similar streams. As a result many of the equations derived for forced convection in streamline flow are also applicable to the corresponding cases of mass transfer.

Chemical Engineering Progress Symposium Series, **50, No. 10, 121 (1954).**

Vapor-Liquid Phase Equilibria: Hydrogen Chloride—Ethane

Jay H. Ashley and George M. Brown
Northwestern Technological Institute

Experimental phase-equilibria measurements were made on the system hydrogen chloride–ethane in the temperature range of —60° to —30° C. with recirculation-type equipment designed for high pressure. This system possesses low-boiling (maximum pressure) azeotropes with compositions of about 50% ethane. Activity coefficients over the entire composition at these temperatures were obtained from the experimental data, and heats of mixing were calculated from the activity coefficients.

Chemical Engineering Progress Symposium Series, **50, No. 10, 129 (1954).**

Integral Isobaric Heat of Vaporization of Methanol-Benzene Mixtures

J. A. Tallmadge, D. W. Schroeder, W. C. Edmister, and L. N. Canjar
Carnegie Institute of Technology

An apparatus operated at atmospheric pressure and at temperatures from 55° to 80° C. is described for the simultaneous measurement of the integral isobaric heat of vaporization, vapor-liquid equilibrium, and dew-point temperature. Experimental calculations of this heat of vaporization require approximate specific heats for sensible-heat correction. The absolute accuracy of the heats of vaporization is estimated as 0.3%, and the shape of the curve is believed good to 0.1%. The dew-point temperatures have a precision of 0.1° C. The vapor compositions of the vapor-liquid equilibrium have a precision of 0.1%, but the precision of the liquid compositions is lower.

Chemical Engineering Progress Symposium Series, **50, No. 10, 137 (1954).**

based on talk given before
Instrument Society of America
September 15, 1954

limitations of our tax structure on prosperity

C. G. Kirkbride

President, A.I.Ch.E.
President, Houdry Process Corp.
Philadelphia, Pa.

It may be surprising that after Congress had passed the first constructive tax legislation in seventy-five years, I would select such a title as "Limitations of Our Tax Structure on Prosperity." Frankly, I will admit freely that the tax law as recently passed by Congress is one of the most constructive pieces of legislation of our time. President Eisenhower and the 83rd Congress deserve much credit for the courage and intelligence they have displayed in this constructive legislation.

Even so, it is only a step in the right direction. There are many more steps to be taken before we have a tax law that does not discourage individual private enterprise. All that can be said for the new tax law in this regard is that it is less discouraging to individual private enterprise than the previous law was, but it still has some serious barriers that will prevent us from attaining the degree of prosperity that is possible.

The new tax law still has the feature of progressive rate of taxation of personal incomes which makes it virtually impossible for a poor man to gain any appreciable wealth. I am disregarding here, of course, unfair, unethical, and dishonest methods of gaining wealth. It is impossible today for a person to attain wealth except through capital gains. One must first have wealth to gain any appreciable wealth. Consequently, the feature of progressive rate of taxation of personal incomes which remains in the new law discriminates against those who were born poor.



The new law also still has a high corporate tax rate. I do not know how long Congress can delude the American people into believing that corporations can be taxed. George Koether, automotive editor of *Look Magazine,* showed very clearly in the issue of March 24, 1953 that corporations cannot be taxed. He explained in grammar school language that corporations are nothing but pieces of paper and must of necessity hide their taxes in the prices of their products; therefore, the corporate tax ends up as nothing more than a hidden sales tax which the consumer must pay. I am opposed to the corporate tax. As a consumer, I much prefer a sales tax because then I know how much tax I am paying. I do not believe that Mr. and Mrs. America realize that over thirty per cent of the money they spend on commodities goes to pay the corporate tax which is hidden in the price of the commodities.

There are several silly and even stupid features of the new tax law, but I shall discuss only one of them, namely—that feature of our tax law which limits the rate at which a tool of production can be amortized. In this paper I am using the term *tool of production* in its broadest sense to include buildings, prime movers, mechanical tools of all types, electrical tools of all types, boilers, furnaces, process equipment such as distillation columns, absorbers — anything that is used to produce consumer goods but which does not become a part of the consumer goods. *Tools of production*, therefore, are capital goods.

Before I take up this subject, however, I want to discuss just a few of the classical achievements of our American Way of Life. My purpose in doing this is to show you that investment in new tools of production, and not legislation, nor the cries of social uplifters, is the primary cause of our high standard of living. Demagogues have tried and are still trying to make you and me believe that most of the advances we have made in our standard of living are a result of legislation and the efforts of do-gooders and social uplifters. Nothing could be further from the truth. After I discuss some of the classical achievements* of the American Way of Life, I am sure that you will agree that our high standard of living is a result of heavy investment in tools of production. Then I hope that you will see why it is so important that nothing be permitted to discourage investment in new and better tools of production.

Accomplishments of the American Way of Life

The American people enjoy the highest standard of living the world has ever known. Yes, the average American is able to purchase far more consumer goods and useful services than the average citizen of any other country in the world. The reason for this is that the average worker in the United States is provided with tools of production which enable him to produce more consumer goods and useful services than the average worker of any other nation in history. As an example, in the petroleum and chemical industries of the U.S.A. each employee on the average is provided with tools of production valued at almost forty thousand dollars. Furthermore, each worker in the U.S.A. has at his command an average of about eight horsepower of mechanical energy to aid him in doing his work.

I should like to emphasize at this point that the American standard of living is not measured solely in terms of material things such as clothing, houses, vacuum cleaners, and automobiles, however, the United States is the only nation in the world where the standard of living is so high that the consumer price index includes such items as television sets, group hospitalization contracts, and beauty-parlor services. We also lead the world in more leisure, better health, more schools, more parks and playgrounds, more libraries, more art museums, more theatres, and more symphony orchestras. We lead the world in contributions to welfare institutions as well as in foreign aid. We top the world in college attendance and book publication.

We have been able to make all these cultural and social gains because we have developed the capacity to pay for them. We sometimes have been criticized for being too materialistic but the critics are often economic illiterates. They cannot seem to understand the simple fact that social and cultural gains must be paid for in some way. We Americans have chosen to pay for them ourselves. We have developed as a nation in such a way as to afford many cultural and social advantages as well as material gains.

The great social advances we have made would not have been possible unless our dynamic economy had had the ability to pay for them. Take, for example, the reduction in working hours per day and per week in industry. At the time of the First World War, and even until the early twenties, it was common for the industrial employee to work at least twelve hours a day, seven days a week.

Today he works eight hours a day and five days a week. The eight-hour day became standard not because of legislation and not because of any demands by labor unions. As a matter of fact, the steel industry had long before urged its employees to accept the eight-hour day, but this was rejected by the employees because it would have resulted in sharing the work. The employees knew that it would have lowered the income of each employee.

Adoption of the eight-hour day was brought about only when the worker could equal or exceed in eight hours his previous production in a longer working period. This was made possible only by providing the worker with new and better tools of production. Had the eight-hour day been adopted without the improved tools of production the worker would have produced proportionately less and his income would have been reduced correspondingly.

It is fortunate, indeed, that we did not try to reduce the work week by legislation as the social uplifters and do-gooders were trying to do. Instead we chose to do it by providing the workers with new and better tools of production. This necessitated a huge increase in investment cost for capital goods. Progress was made in this way, whereas a loss in living standard would have been experienced if we had tried the legislative route.

Another classic example of technological progress is found in the field of farming. Before the nineteenth century there had been no significant change in the methods of farming. In 1800 it required nine people on a farm to feed themselves, plus one other person. Today one person on a farm feeds himself plus fourteen other people. This astounding progress also was made as a result of new and better tools of production being provided the worker. It was not achieved as a result of legislation or government subsidy. The social do-gooders and political demogogues have exerted every effort to make people believe that they were responsible for this agrarian progress. I am sure it will not take you long to see where the credit properly belongs.

Technological developments such as the plow, the reaper, the binder, the tractor, the thrasher, and the combine—yes, technological developments such as these—are responsible for the progress made on the farm in the last one and one-half centuries. The farmer of today does not have "hay seeds sticking out of his ears." He is a business man that looks and lives like any other business man. Technological developments made this possible.

Still another classic example of increasing our living standard by technological progress is the field of transportation. The development of the automobile, high-quality motor fuels and lubricants, and hard-surface roads have revolutionized the life of the average American. At the beginning of this century it was common for people to live their entire lifetime within a single county.

I can recall very distinctly that in my

*** In the discussion of accomplishments of the American Way of Life I have drawn freely from the paper "Formula for Reform" by Harold Brayman, director, Public Relations Department, E. I. duPont de Nemours & Co.**



boyhood in Oklahoma it was a rarity for a tourist to pass through that state. There were no hard-surface roads in Oklahoma then. I recall how impressed I was during the early twenties to learn that the parents of a friend of mine drove from Chicago to New York City without getting off hard-surface roads. The situation today, however, is much different. Tourists vacation in any part of the United States they desire. They drive their automobiles on the finest hard-surface roads from Maine to California and from Mexico to Alaska.

Workers formerly had to live within walking distance of the factories in which they worked. Such industrial areas are not pretty and certainly do not make attractive residential areas. But today the average worker, because of the automobile and hard-surface roads, can live miles from his work in beautiful residential areas.

Before I leave this subject, I want to cite another classic example of how our living standard has been increased. Were it not for technological development, women would have to stay home to take care of the spinning, weaving, and dyeing so that they and the other members of their families would have clothes to wear next year. The inventions of the spinning frame and the loom represent the beginning of the textile industry, which relieved women of the drudgery of making cloth for their families. No doubt, too, with automatic dishwashers, automatic clothes washers, automatic clothes dryers, automatic ironers, vacuum cleaners, electric mixers, automatic electric stoves, and the like, women must have much more leisure time than women did fifty years ago. I am sure that if you give this a little thought you will agree that this greater leisure is not a result of legislation but, instead, is a result of technological development.

The miraculous rise in the American standard of living was accomplished under a type of capitalism which I call the incentive system. It is based on individual freedom with rewards to the individual commensurate with his contribution. Competition is the life blood of this system. Under the incentive system technological development has flourished, nevertheless the industrial growth that provided our present high standard of living would never have taken place had it not been for the fact that people were willing to save and risk their savings on investments in new tools of production. Risk capital is a prerequisite to technological development. Furthermore, there must be an incentive to risk one's savings in a hazardous enterprise. There must be a reward for success which justifies the risk. Now, if we are to raise our standard of living to an even higher level, we must create and provide our workers with even better tools of production. Is this possible? And if so, how should we proceed?

General Program for Greater Prosperity

Applied research and deevlopment have played a major role in creating new tools of production. In particular, the creation by research and development of entirely new industries has provided such a demand for labor that laborsaving devices could be adopted in practically all industries without causing unemployment. This is a dynamic economy when new enterprises, new industries, or expansions in existing industries are being brought about so that more and more labor is required.

Furthermore, the possibilities are unlimited for research and development to increase our living standard beyond anything imaginable today. As an example of what can be done, the Du Pont Company has stated that 60% of its sales in 1950 came from products that were unknown or in the research stage in 1930. It is expected that in 1974 its sales will come from products of which 60% are unknown or in the research stage today.

Nevertheless, research and development without the necessary risk capital will not get the desired end result. It requires risk capital to provide the new and improved tools of production that are created by research and development. Furthermore, there must be sufficient incentive to persuade people to risk their savings on investments in these new tools of production.

There have been several periods in the history of western civilization when inventive ingenuity flourished but new tools of production were not created for the worker. Such periods of inventive ingenuity extend back at least seven hundred years prior to the Industrial Revolution in England. For example, the period of perhaps the greatest inventor of all time, Leonardo da Vinci, was one of outstanding inventions. According to Mumford, to catalog Leonardo's inventions and discoveries is almost to outline the structure of modern technology. Even the heliocopter and parachute were invented by Leonardo in the fifteenth century. Yes, Leonardo probably made more fundamental inventions than all other inventors combined. He was in fact a far greater engineer than he was a painter.

Why then was that period not one of rapid technological development? Historians have stated that the reason was that the people of that time would not surrender to the machine. Such a statement reflects a complete lack of understanding of why we have had rapid technological development. The fact is that we have individual freedom, which was unheard of in the time of Leonardo. Technological development began with the Industrial Revolution in Great Britain at the time of Watt, the inventor of the steam engine, and of Boulton, the business man. The industrial revolution in Britain would never have taken place had not someone like Boulton been willing to risk his savings in new and untried tools of production. At that time in the history of Great Britain there was a real incentive for Boulton

to risk his savings in technological development. There were no tax laws at that time that would rob him of his reward if he were successful.

People risk their savings in a new tool of production because they expect it to be used to produce consumer goods or useful services at a sufficiently high rate and over a long enough period of time to pay for itself. Thus, investment in new tools of production involves risk, because plans do not always develop as anticipated. A progressive economy necessitates the risk of trying new tools of production. Furthermore, the more progressive the economy, the greater the risk involved in a given investment in a new tool of production because the greater the chances will be that a better tool of production will be created at an early date which will make the existing tool of production obsolete. The living standard in such an economy will be pushed rapidly to higher and higher levels provided the necessary risk capital and the necessary incentives exist.

In a dynamic economy such as ours, people will save and invest their savings in new tools of production if the potential reward is great enough to justify the risk. It is of extreme importance, therefore, that an atmosphere be maintained that in no way discourages people from risking their savings in new tools of production. The very life of our economy depends upon technological development coupled with the necessary risk capital and the proper incentives to invest this risk capital in new methods. Competition is the life blood of this economy.

I am convinced that we can have prosperity that far exceeds anything we have ever experienced. It is within our grasp. Only stupidity and greediness on our part can prevent us from attaining this goal. At this point, therefore, I want to discuss those features of our tax structure which discourage the creation of and the investment in new tools of production.

Our Tax Structure

In an address I made at Atlantic City in 1951, I stated that "the limitation of depreciation or amortization rates imposed by the Department of Internal Revenue is one of the most destructive of the adverse features of our tax structure." I am happy that the new tax law recognizes this, even though Congress saw fit only to mitigate the barriers to prosperity. The new Law indicates that the 83rd Congress is the first one in our history to be able to grasp the sharp difference between the purposes of depreciation and amortization.

The limitations on amortization rates as established by the new tax law are less severe than previously. The new law permits about two thirds of the cost of a new tool of production to be charged off the books in one half the estimated life of the tool. In this regard, the new law probably would not be too great a burden for a well-financed business. It would not tend to discourage unduly the installation of new tools of production by such well-financed firms. However, many an industrial giant today started on little more than a shoestring. New industries can be born again with very little capital. Poorly financed firms suffer real hardship if the tax law does not permit them to write off their investment costs in new tools of production before the Government begins grabbing taxes. Such investment costs are true costs in the business and there should be no limitations on the rate of amortization. From a factual standpoint, no profit has been made on any tool of production until the tool has produced sufficient consumer goods or useful services to pay for itself. This feature of the law of limiting the amortization rates is a form of poison which reacts to kill incentive. Small doses can be administered without killing the patient; however, it is not a sound policy to administer small doses of poison just because the patient won't die. We should have the highest level of prosperity possible.

If by limiting the amortization rate the government collected more taxes from a given investment, I would be able to understand why the Government greedily grabs taxes before a tool of production has made enough profit to pay for itself. I could understand it even though the law discourages the installation of new tools of production. The facts are, however, that the government will collect the same amount of taxes during the life of the tool because only 100% of the cost of the tool can be amortized. No more than 100% of the cost of the tool can be charged off the books.

Congress did make an outstanding contribution when it eliminated practically all limitations upon whether research and development costs shall be charged to expense or capitalized. From the standpoint of future prosperity this change in the law is the most constructive of the changes made. It is too bad, however, that Congress did not see fit to be as progressive in the case of investments in new tools of production.

I realize that the Government must raise by taxes the amount of money it spends; however, there is no reason why an adequate tax law cannot be evolved that does not discourage in any way our technological development. Yes, this is possible if the objective of the tax law is limited only to raising the necessary revenue to run the Government. If Congress is dedicated to the removal of all barriers to prosperity, it should remove all restrictions to amortization of new tools of production.

In my address at Atlantic City I devoted considerable attention to an analysis of the British economy in an effort to point out mistakes that they have made that we could and should avoid. I was impressed when the book "We Too Can Prosper" by Graham Hutton, agreed with my conclusions. It presents a consensus of the conclusions reached by the sixty-six teams of the Anglo-American Council on Productivity. These teams made thorough studies of how and why the American economy functions. The book states: "No people now living deserves its present standard of life. That standard arises from the work, thrift, and skill of former generations—or from their lack of work, their waste, and their lack of skill. The Americans of today could not live as they do if their forefathers had not broken the wilderness, lived in zero weather in three-sided open faced camps, worked like Trojans in wooden shacks, toiled to raise towns, and saved

to raise cities." I am impressed by the depth of understanding of the American Way of Life of this British author. The second statement I wish to quote from Mr. Hutton's book is: "The American workman produces more in his hour, year, or life of work, not because of a higher American average of brain, brawn, skill, and potentiality, but because of much bigger (and easier) saving and capital investment, better arrangement of work, better application of the human being to the work as arranged, and better rewards for the work. That is the overwhelming and unanimous conclusion of the Anglo-American Council on productivity teams. It is borne out by all available evidence."

I must emphasize that this conclusion was reached unanimously by sixty-six teams of British specialists who studied our economy so that they might be in a position to improve their own economy. There is no doubt whatever that their conclusion is correct. Then why do we Americans permit a tax structure that discourages even in small measure the very thing that gives us our high standard of living?

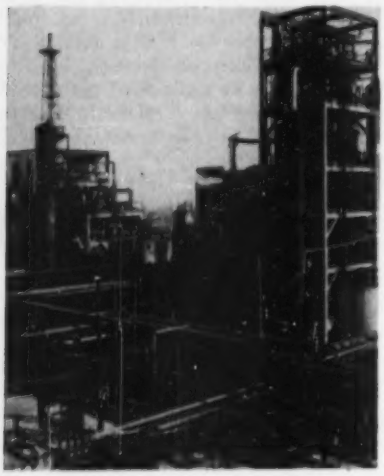
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In the foreground are major industrial waste control facilities for Barrett's new cumene-phenol process, i.e., concrete gravity-type oil-water separator, and recovery and control facilities for organics.



Team work and close liaison between plant management and the coordinating function of the Industrial Waste Development Section was primarily responsible for the accomplishments presented in this article. A key member of this team, C. J. Murphy, works manager (on the right), Frankford Works. On the left is co-author A. N. Heller.



Another view better illustrates the works layout of Barrett's new cumene-phenol process. In the left background is a flare tower—an air pollution control device used to burn off-gases from this process.

contribution of management and chemical engineering to process waste control

A. N. Heller and M. E. Wenger

Barrett Division, Allied Chemical & Dye Corporation, New York, N. Y.

The control of industrial wastes presents to the process operating organization considerations of a technical, economic, and community-relations nature. It is generally recognized that the problem is complex and requires cooperation and understanding on the part of industrial management and public bodies concerned with air and stream pollution abatement.

Management

The participation of many members of the industrial team is necessary if a company is to cope successfully with the problem, and the coordination of this participation is essential to development of an effective program of control. Along these lines, Barrett formed its Industrial Waste Development Section in 1948 to coordinate the activities of its personnel involved with air and stream pollution abatement matters.

This section, formerly associated with the Research and Development Department, is currently an integral part of the Manufacturing Department and consists of a team of fifteen chemical engineers and chemists. Its objective is to define and solve the industrial waste problems associated with Barrett operations, to coordinate the skills of other Departments if required in solution of these problems, and to represent management in dealing with public bodies responsible for air and stream pollution matters. In the final analysis, it is recognized that the support and understanding of management at the highest level is a must if air and stream pollution abatement problems are to receive first- instead of second-rate thinking.

To augment this program, Barrett management, as a matter of policy, directed that whenever the Manufacturing, Engineering, or Research and Development Departments were to make recommendations as to new construction or maintenance projects, the impact of air pollution and process waste problems were to be evaluated and facilities to handle effluents specified.

An excellent illustration of the implementation of the above policy was the installation of facilities to control industrial wastes from Barrett's new cumene-phenol process plant—a complex petrochemical operation (illustrated above). In addition, engineers were assigned to the start-up team for the new plant to handle all problems associated with industrial waste control.

As it is generally recognized that the solution of industrial waste problems is a primary function of plant operations, a close working relationship between plant management and the coordinating activity is mandatory. Barrett's I.W.D.S. was directed to work closely with plant management in matters of policy and implementation of technical programs. The marked progress made in recent years in both air and stream pollution abatement at Barrett's Frankford Works (Philadelphia, Pa.)—partially detailed in subsequent portions of this paper—notably illustrates the benefits derived from this close working relationship.



The complexity of Barrett's new cumene-phenol process is best illustrated by the degree of automation evidenced above. Industrial waste control facilities are functionally a part of this system.

Chemical Engineering

In the manufacture of many organic chemicals wet instead of anhydrous processes are used. The wet process utilizes water for both indirect and direct phases of unit operations, such as cooling, scrubbing, and extracting. In the direct use of process water, evidence of raw materials, intermediates, final product, and unknown by-products of the reaction will be found in the process waste waters. The question as to whether process waste waters constitute a stream pollution problem depends on many factors, such as location of the plant, volume and characteristics of process wastes, and size of receiving stream.

The subsequent presentation will show that it is feasible technically and economically to abate the process waste streams from the manufacture of synthetic phenol (sulfonation process) by changing a wet process to one that is cyclic and essentially anhydrous. The primary chemical engineering key to the solution of this problem is control of the water balance, that is, water in and out of the process.

Definition of Problem

A comprehensive industrial waste survey of the Frankford Works early in 1948 revealed that phenolic compounds were a major constituent in the industrial waste discharge and that the industrial wastes from the synthetic phenol department were primary contributors. Detailed process study of the unit operations of the synthetic phenol department was required therefore to determine the pattern of pollution abatement.

Sulfonation Process for Synthetic Phenol

Figure 1 is a schematic flow diagram of the sulfonation process for production of synthetic phenol. This process has the following eight steps:

1. Sulfonation of benzene with sulfuric acid to form benzene sulfonic acid
2. Neutralization of the benzene sulfonic acid with sodium sulfite to produce sodium benzene sulfonate, sulfur dioxide, and water
3. Fusion of the sodium benzene sulfonate with molten anhydrous sodium hydroxide to produce sodium phenate and sodium sulfite
4. Puddling of the molten fusion mass with sodium sulfite liquor and/or water to produce a solution of sodium phenate and to precipitate the sodium sulfite
5. Centrifuging of the puddled mass to separate the sodium phenate-sodium sulfite solution from the sodium sulfite crystals
6. Acidification of the sodium phenate-sodium sulfite solution with sulfur dioxide gas to convert the sodium phenate to phenol
7. Distillation of the crude phenol to produce refined phenol
8. Drying of the centrifuged sodium sulfite cake

Table 1 presents the four major chemical reactions for this process: sulfonation, neutralization, fusion, and acidification.

Definition of Problem—Synthetic Phenol Department

All fresh water discharged into the process and industrial wastes from the process were measured, see Table 2. A total fresh water input of 17,427,000 gal.

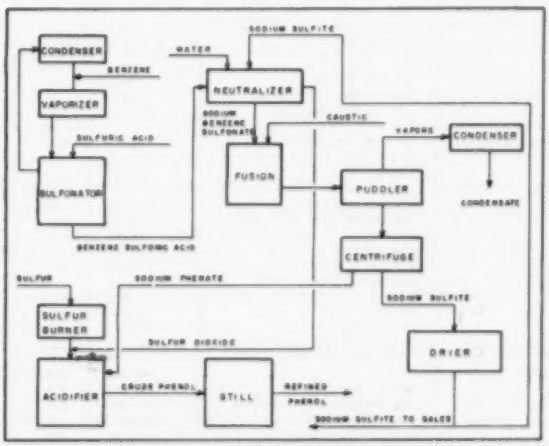


Fig. 1. Sulfonation process.

CHEMICAL REACTIONS

SULFONATION

$$C_6H_6 + H_2SO_4 \longrightarrow C_6H_5SO_3H + H_2O$$

NEUTRALIZATION

$$2\,C_6H_5SO_3H + Na_2SO_3 \longrightarrow 2\,C_6H_5SO_3Na + SO_2 + H_2O$$

FUSION

$$C_6H_5SO_3Na + 2\,NaOH \longrightarrow C_6H_5ONa + Na_2SO_3 + H_2O$$

ACIDIFICATION

$$2\,C_6H_5ONa + SO_2 + H_2O \longrightarrow 2\,C_6H_5OH + Na_2SO_3$$

Table 1

per year produced 18,408,000 gal/yr. of industrial wastes. The major points of water consumption and discharge were (1) sulfur dioxide scrubber, (2) centrifuge, (3) sulfite drier scrubber, and (4) still during cleaning operations. An analysis of the various process wastes was made to determine the major constituents. Unknown by-products of the reaction were not included in this study since the data of operation experience indicated, Table 3, that industrial waste control required primarily a reduction in both the phenolic compounds and sodium sulfite in the process wastes.

Solution of the Problem

Engineering studies determined the feasibility of recovering phenolic compounds from the process waste streams by solvent extraction. The processes evaluated indicated that economic return is minimal and that operating difficulties would probably be encountered because of the chemical characteristics of some of the process wastes. Solvent extraction, therefore, was eliminated as a feasible method for solution of the problem, and chemical and biological treatment of the industrial wastes was carefully studied. The data indicate not only an expensive operating penalty per year but considerable doubt as to expected performance.

Table 3 disclosed a marked similarity in the chemical characteristics of the various process wastes; Table 2 showed that many of the process waste streams were large in volume. It was expected, therefore, that the industrial wastes from the synthetic phenol department could be minimized by (1) reduction in volume of the wastes and (2) recycle of the waste streams in lieu of fresh water input. This approach resulted in an economical solution of the industrial waste problem of the synthetic phenol department. The technological aspects of containing three of the major process streams, namely (1) still boil-out, (2) excess sulfite liquor, and (3) sulfite drier scrubber effluent, will be described to show the application of water balance as a primary instrument of industrial waste control.

Phenol Still Clean Out

Before June, 1949, the distillation residue was removed from the still by three washes of 2,500 gal. each of fresh water, a total of 7,500 gal./run or 1,515,000 gal./yr. The cold water was charged to the still and heated to boiling; then a solution of the distillation residue was discharged to Frankford Creek. The resultant phenol still boil-out contained approximately 5% phenolics and dissolved organic and inorganic salts. Three separate washes were required to effect complete solution and removal of the distillation residue since the salts were not completely soluble in a single wash.

Laboratory investigation of the cleaning out process demonstrated that one part of the distillation residue was completely soluble in five parts of water when the water was charged at 95° C. The distillation residue, however, was only partially soluble when the same volume of water was charged cold and then heated to 95° C.

Plant-scale testing demonstarted the feasibility of using 95° C. water in lieu of cold water, and this modification yielded a 66.6% reduction in the number of washes (from three to one) and a 60% reduction in the volume of water utilized in the process (from 7,500 to 3,000 gal./run).

Although a reduction in volume of the industrial wastes was achieved, the chemical discharge remained the same. Further laboratory studies disclosed that acidification of the still boil-out solution with sulfuric acid would produce two phases—a phenolic rich phase and an aqueous solution of phenolics and salts. The quantity of the phenolic rich phase was dependent, however, on the concentration of phenolics in the still boil-out solution. Since the quantity of phenolics of each boil-out was reasonably constant, concentration of the solution could be obtained only by a reduction in volume of the boil-out solution. The physical design of the still prevented use of fewer than 2,500 to 3,000 gal. of water per run; therefore, recycle of a portion of the previous boil-out was investigated as a means of reducing the input of fresh water. Laboratory and plant-scale studies confirmed the recycle process. The final proportions for the boil-out solution charged to the still were fixed at the following values

1. Recycled boil-out solution	2,250 gal.
2. Water	750 gal.
3. Total	3,000 gal.

The foregoing represents a 90% reduction in the quantity of water required for the boil-out procedure, and the concentration of phenolics in the solution increased from 5 to 15%. The still boil-out cycle was reduced 4.5 to 1.75 hr., a saving of approximately 600 distillation hr./yr.

WATER BALANCE – 1948

SOURCE	FRESH WATER GAL./AN.	INDUSTRIAL WASTES GAL./AN.
SULFONATOR SCRUBBER	112,000	836,000
NEUTRALIZER	420,000	0
SULFUR DIOXIDE SCRUBBER	1,087,000	1,709,000
PUDDLER	392,000	355,000
CENTRIFUGE	1,178,000	1,190,000
SULFITE DRIER SCRUBBER	12,860,000	12,893,000
STILL BOIL-OUT	1,515,000	1,740,000
STEAM DISTILLATION	63,000	0
TOTAL	17,427,000	18,408,000

Table 2

Table 3

INDUSTRIAL WASTES – 1948

SOURCE	COMPOSITION		
	CHEMICAL	LB./ANNUM	PERCENT
SPENT SULFONATOR SCRUBBER CAUSTIC	SODIUM HYDROXIDE	78,000	1.9
	SODIUM BENZENE SULFONATE	52,000	1.2
	SODIUM SULFITE	308,000	7.3
SULFUR DIOXIDE SCRUBBER EFFLUENT	SULFUR DIOXIDE	280,000	2.0
PUDDLER CONDENSATE	PHENOL	28,000	0.7
EXCESS SULFITE LIQUOR	SODIUM SULFITE	8,248,000	180
	SODIUM BENZENE SULFONATE	150,000	1.5
	PHENOL	130,000	1.1
DRIER SCRUBBER EFFLUENT	SODIUM SULFITE	703,000	0.7
	PHENOL	250,000	0.2
PHENOL STILL BOIL-OUT	PHENOL	450,000	5.0
	OTHER PHENOLICS	200,000	1.0
	SODIUM BENZENE SULFONATE	520,000	5.6
TOTAL INDUSTRIAL WASTES	PHENOL	892,000	0.55
	OTHER PHENOLICS	200,000	0.12
	SODIUM BENZENE SULFONATE	732,000	0.45
	SODIUM SULFITE	8,305,000	5.15
	SODIUM HYDROXIDE	78,000	0.05
	SULFUR DIOXIDE	280,000	0.18

Upon completion of above program, facilities were installed for acidification of the boil-out solution. The modified still boil-out procedure and the method of recovery of chemical values are presented in Figure 2. The crude recovered synthetic acids (phenolic-rich phase) were returned to the phenol still and separated into three fractions. The acid water fraction was processed by return to the crude phenate tank in the synthetic phenol department. The 39° phenol fraction was blended with subsequent still charges for production of refined phenol. The distillation residue was blended with other plant residues for recovery of values. Time for this distillation was made available by reduction in the time cycle for still boil-out.

The aqueous phase contained sodium benzene sulfonate and phenol. Because water was required at the neutralizer for production of sodium benzene sulfonate, the aqueous phase could be used in lieu of fresh water. The neutralizer required 420,000 gal./yr. of water, and the volume of the aqueous phase from acidification of the still boil-out solution was 238,000 gal./yr. Substitution of the aqueous phase for fresh water therefore appeared feasible, but extensive study was required before final acceptance of this change since it was necessary to determine the possible detrimental effect of unknown by-products in the aqueous phase on the yield and quality of the product—synthetic phenol.

Next the industrial wastes from the still boil-out were completely eliminated from the plant discharge and all chemical values were recovered (*1*).

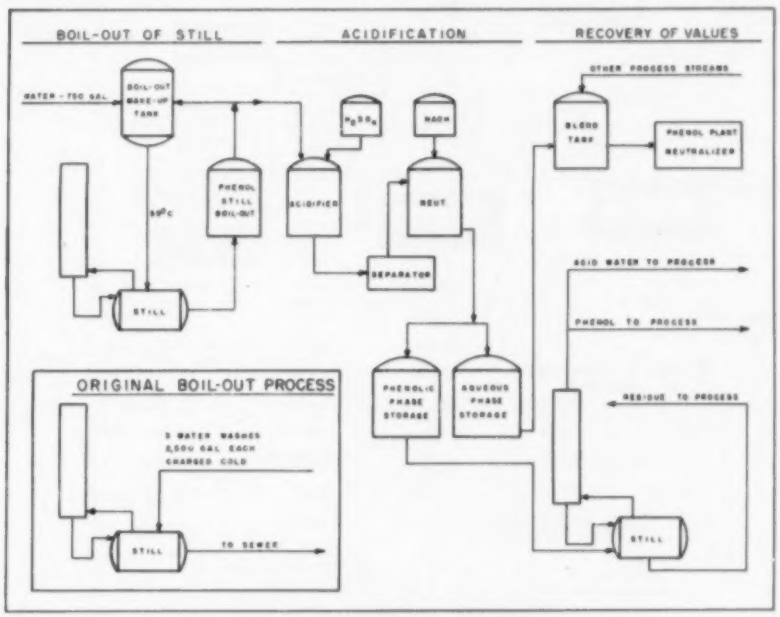


Fig. 2. Recycle boil-out process.

Excess Sulfite Liquor

Disposition of the excess sulfite liquor produced in the acidification of sodium phenate solution posed a severe problem since it was not economical to recover the sodium sulfite by evaporation. Study of the various unit operations indicated this stream could be used in place of fresh water for washing the sodium sulfite cake at the centrifuge. The primary purpose of the wash water was displacement of the sodium phenate-sodium sulfite solution from the cake. It was believed that sodium sulfite liquor would be as effective a washing agent as fresh water. The fresh water input to the centrifuge was 1,178,000 gal./yr. and the excess sulfite liquor totalled 1,190,000 gal/yr. If allowance was made for the salt content of the sulfite liquor, these two streams were in balance. Plant testing of the proposed change demonstrated that washing with sulfite liquor was satisfactory. An additional 50,000 gal./yr. of fresh water were required for flushing the wash water inlet nozzles in order to obviate the precipitation of sodium sulfite on the nozzles.

The use of excess sulfite liquor instead of fresh water eliminated a major industrial process waste problem and also permitted the recovery of chemical values within the synthetic phenol process.

Sulfite Drier Scrubber Effluent

The centrifuged sodium sulfite cake was charged to a rotary, direct-fired drier. Since this cake was wet with a mother liquor containing sodium phenate in small quantities, the exhaust gases from the drier contained phenol in addition to the expected sodium sulfite fines. These exhaust gases were passed through a cyclonic separator to remove and recover the major portion of the sodium sulfite fines. The gases from this separator were passed once through a countercurrent water scrubber for removal of residual sodium sulfite fines and phenol.

Operation of the scrubber on a once-through basis created a stream pollution problem since the concentration of the sodium sulfite and of the phenol in the waste stream was too low for economic recovery and the volume of the stream was too large for containment within the process. The obvious correction for the large volume was to operate the scrubber on a recirculation basis. The shift to a recirculation process yielded a marked change in the volume of the water required and in the volume of the process stream; that is, water input decreased 95.9%—from 12,660,000 to 524,000 gal./yr., and process stream volume decreased 95.6%—from 12,883,000 to 572,000 gal./yr. In addition, the concentration of sodium sulfite in the process stream increased from 0.7 to 12.5%.

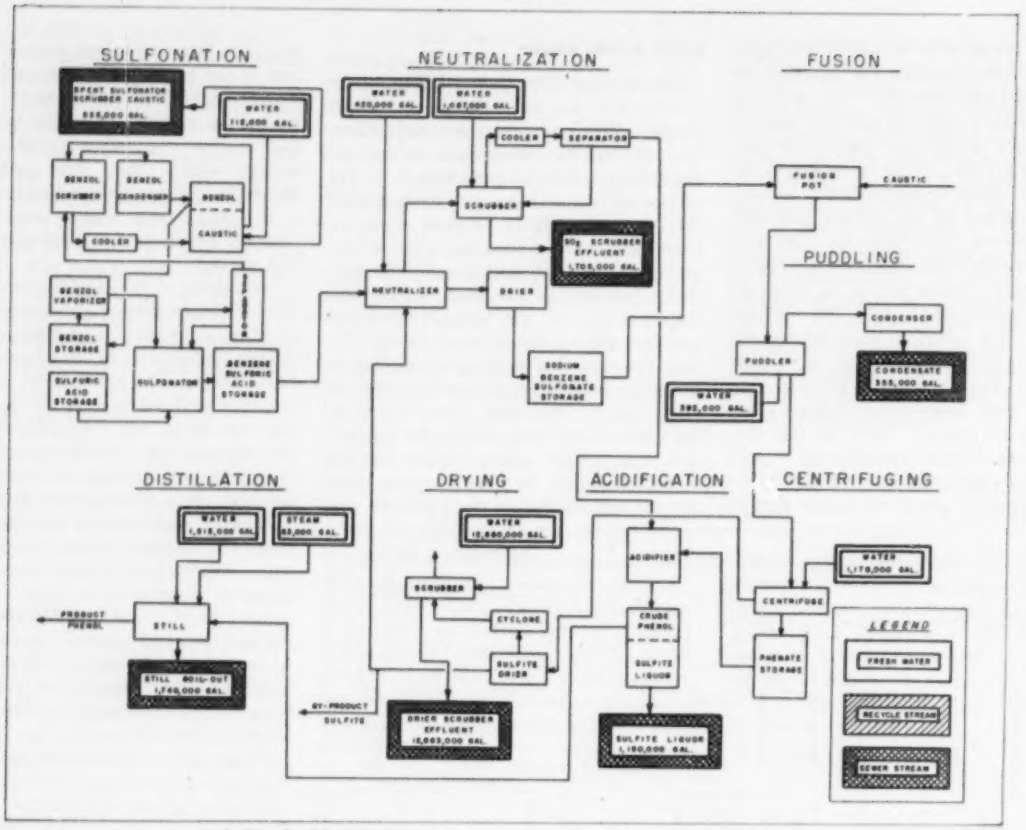
Reduction in volume of the process stream and the increase in concentration of the sodium sulfite permitted containment of concentrated sulfite drier scrubber effluent within the process by substitution for fresh water at the puddler. The chemical value of the sodium sulfite was thereby recovered by this process modification.

The effluent from the once-through scrubber contained 0.2% phenol (250,000 pounds per annum). Plant operation proved that use of a recirculation scrubber resulted in inefficient absorption of the phenol because of the partial pressure of phenol over water and/or salt solutions. The effluent from the recirculation scrubber contained 0.9% phenol —50,000 lb./yr. The remaining 200,000 lb./yr. of phenol not being absorbed in the scrubber were discharged to the atmosphere without any air pollution problem.

Disposition of Minor Wastes

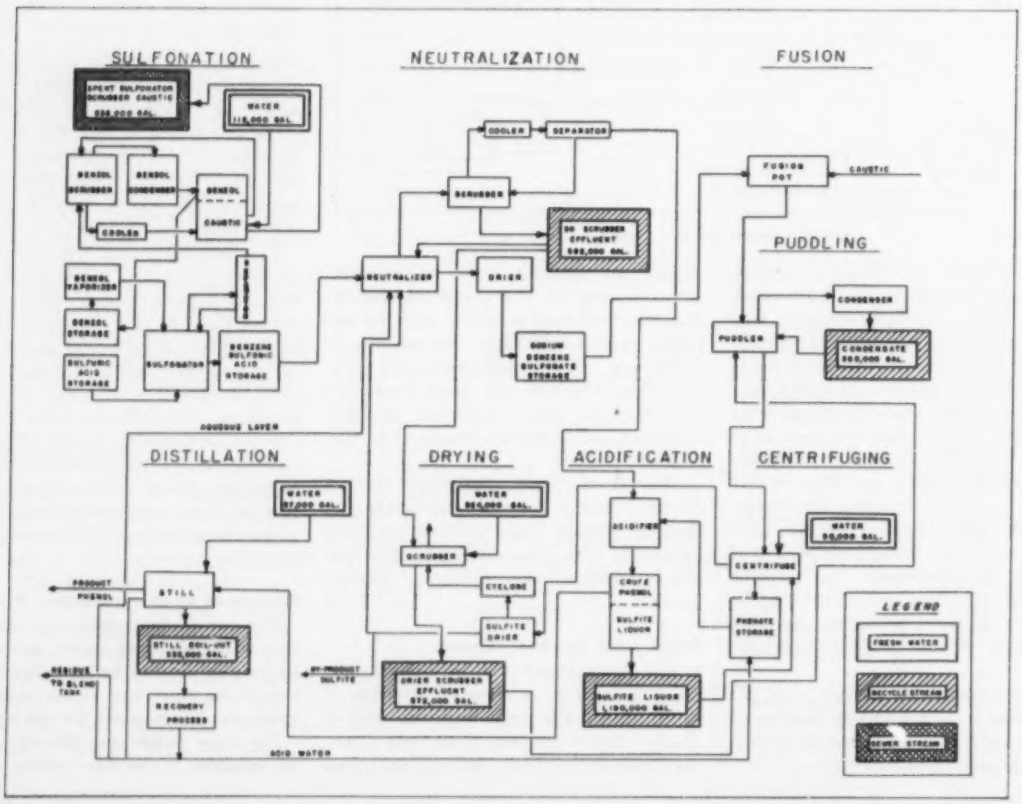
Discharge of the puddler condensate, essentially a phenol-bearing stream, was eliminated by recycling it to the puddler. This change increased the water input at this point, but the system was able to absorb the additional water.

The sulfur dioxide gas released during the neutralization of benzene sulfonic acid with



▲ Fig. 3. Water balance, 1948.

▼ Fig. 4. Water balance, 1953.



sodium sulfite was passed through a submergence-type scrubber to remove traces of entrained solids. Gases exiting from the scrubber passed through a cooler to reduce the temperature of the gases and to condense water vapor in the stream. The condenser water was returned to the constant level scrubber. In addition to returned condensate, the scrubber was provided with 1,087,000 gal./yr. of fresh water. As study of this unit operation disclosed that fresh water was not required, it was eliminated from the operation. The industrial wastes were reduced from 1,705,000 to 592,000 gal./yr. The resultant effluent after neutralization of the sulfurous acid could be contained within the process. Containment was required since the addition of the aqueous layer from the acidification of the still boil-out solution to the neutralizer resulted in the appearance of phenol in the scrubber effluent, which previously had been a nonphenol bearing stream.

The sulfonator scrubber caustic effluent is the only industrial waste from the synthetic phenol process which did not require abatement.

Results—Stream Pollution Abatement Program

The over-all effect of a study of the water balance of the sulfonation process for production of synthetic phenol is given in Table 4. By 1948 the process consumed 17,427,000 gal./yr. of fresh process water, none of which was recycled to the process. By 1953 the total process water demand had been reduced to 3,644,000 gal./yr., a reduction of 84.8%, 2,861,000 gal./yr. of this water being recycled to the process. The final net demand is 783,000 gal./yr., which represents an over-all reduction of 95.5% in the fresh water input.

The effect of reduction in fresh water demand and of recycle of process streams instead of fresh water is shown in Table 5. The industrial wastes in 1948 totalled 18,408,000 gal./yr. By today the volume of process streams has been reduced to 4,171,000 gal./yr., a reduction of 77.3%. However, 3,636,000 gal./yr. of the current process streams is being recycled to the synthetic phenol process instead of being discharged as industrial wastes. This leaves a discharge of 535,000 gal./yr., which represents an over-all reduction of 97.1% in the volume of industrial waste discharges.

The changes in chemical discharge are given in Table 6. Phenol, other phenolic compounds, and sulfur dioxide have been completely eliminated from the industrial waste discharge of the synthetic phenol department. The residuum comes from the spent sulfonator scrubber caustic. The over-all reduction is 91.2%. Figure 3 is a flow sheet of the process and the water balance before these studies; Figure 4 shows the changes in process and water balance which resulted from these studies.

Intensive process engineering, laboratory research, and plant-scale studies of the synthetic phenol process demonstrated the importance of water balance as a primary instrument in the control of industrial waste. Process modification resulted in an economical solution of the industrial waste problem; total costs for abatement being $100,000 but returned chemicals being valued at $112,000/yr.

byproduct recovery

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Presented at A.I.Ch.E. Forty-sixth Annual Meeting, St. Louis, Mo.

WATER INPUT — SULFONATION PROCESS

SOURCE	GALLONS/ANNUM — 1948 TOTAL WATER	GALLONS/ANNUM — 1948 FRESH WATER	GALLONS/ANNUM — 1953 TOTAL WATER	GALLONS/ANNUM — 1953 FRESH WATER
SULFONATOR SCRUBBER	112,000	112,000	112,000	112,000
NEUTRALIZER	420,000	420,000	420,000	0
SULFUR DIOXIDE SCRUBBER	1,087,000	1,087,000	0	0
PUDDLER	392,000	392,000	903,000	0
CENTRIFUGE	1,178,000	1,178,000	1,178,000	50,000
DRIER SCRUBBER	12,840,000	12,840,000	780,000	524,000
STILL BOIL-OUT	1,315,000	1,315,000	182,000	0
STEAM DISTILLATION	63,000	63,000	97,000	97,000
TOTALS	17,427,000	17,427,000	3,644,000	783,000

Table 4

◄ Table 5

PROCESS STREAMS-SULFONATION PROCESS

SOURCE	GALLONS/ANNUM TO SEWER 1948	GALLONS/ANNUM TOTAL 1953	GALLONS/ANNUM TO SEWER 1953
SULFONATOR SCRUBBER	535,000	535,000	535,000
NEUTRALIZER	0		0
SO_2 SCRUBBER	1,705,000	592,000	0
PUDDLER	535,000	535,000	0
CENTRIFUGE	1,190,000	1,190,000	0
DRIER SCRUBBER	12,833,000	572,000	0
STILL BOIL-OUT	1,740,000	535,000	0
STEAM DISTILLATION	0	0	0
TOTALS	18,408,000	4,171,000	535,000

Table 6

POUNDAGE DISCHARGE OF CHEMICALS

CHEMICAL	POUNDS/ANNUM 1948	POUNDS/ANNUM 1953	PERCENT REDUCTION
PHENOL	892,000	0	100.0
OTHER PHENOLICS	220,000	0	100.0
SODIUM SULFITE	3,303,000	535,000	83.8
SODIUM HYDROXIDE	75,000	75,000	0.0
SULFUR DIOXIDE	595,000	0	100.0
TOTALS	5,525,000	487,000	91.2

control of costs in production

David E. Pierce * *and Winfield I. McNeill* †

Cost control in production means knowing what amount of money is being spent to produce goods, how this expenditure compares with reasonable expectations, and finally, taking remedial action suggested by the deviation of actual from standard cost. Each of these three elements is essential. Knowing actual cost doesn't do much good without a yardstick for comparison, and an understanding of how bad conditions are doesn't help unless something is done to correct indicated faults. The program outlined here is one important factor that often separates the average company from one which leads competitively.

The individual items of expenditure that make up the total cost of a product include raw materials, direct labor, supervision, maintenance, utilities, depreciation, insurance, and a variety of other charges, all of which must be allocated properly if the true cost of each product is to be known. To complicate the problem, most chemical processes involve several or many operating steps and often result in several products. Accordingly, the question of how costs should be accumulated and then distributed and how standards of performance are to be established must be answered for each plant by a careful study and with the exercise of judgment. There is no single formula that is universally applicable. There are, however, certain principles which apply in most cases.

The first step in organizing for cost control is to establish Process Centers to which actual expenditures are to be charged and for which standard costs are to be developed. There are, in general, two types of Process Centers (1) those covering direct production operations, and (2) those covering auxiliary and service functions. The latter supply utilities and services of various sorts which are needed in the operation of the plant but are not directly concerned with production.

For the Production Centers, the flow sheet of each operation is studied to determine natural breaks in the line where quantities can be measured and where definite responsibilities can be assigned. Wherever inventories are accumulated, it is essential that a Process Center be established and costs collected so that inventories can be priced properly. Even where flow of materials continues directly into another operation, a separate center may be advisable because different equipment and personnel are involved. In some cases the Process Center may include a series of different pieces of equipment, e.g., feeder, reactor, receiving tank, pump, filter, and dryer. This is called the "vertical" arrangement. In other cases the center may be a group of several similar pieces of equipment carrying out the same kind of operation for several processes. A group of filter presses or of vacuum dryers might form such a

* Director, Mfg. Control, Diamond Alkali Co., Cleveland.

† Management Consultant, New York.

"horizontal" Process Center. For a center of this type, there may be a foreman and crew of operators whose time can be charged best to the entire center and then distributed on some rational basis to the various processes served each month, along with charges from Service Centers which have been applied to this Production Center. Whether the center is of the vertical or of the horizontal type, it is important that there be clear-cut responsibility for its costs placed upon the individual having authority to control its operation.

The Service Centers include those supplying utilities (steam, water, electricity, compressed air, etc.), the maintenance department, the control laboratory, the accounting department, the works office, the warehouse, the receiving and shipping department, the hospital, and so on through the long list of auxiliary departments necessary for the over-all production of goods. Each of these must be charged with the expenditures for which it can be held responsible. When the selection of Process Centers has been completed, every dollar spent in the plant should be chargeable to one or another of the centers.

Because all expenditures in the plant must finally be applied to the products made and sold, all costs accumulated in the Service Centers must be distributed to the proper Production Centers. The basis of distribution may be actual quantities delivered (e.g., gallons of water, kilowatt hours of electric energy, pounds of steam, and cubic feet of air), priced at the cost of production and distribution as determined in the appropriate center (boiler house, water-pumping station, etc.). For other Service Centers, such as the maintenance department, charges are usually based on man-hours of work and cost of repair material actually supplied to each center. In the case of general services, such as the hospital and cafeteria, distribution is usually made according to the ratio of number of employees in each area to the total in the plant. For such items of overhead as depreciation, taxes, and insurance, the allocation may be on the basis of investment in the buildings and equipment included in each Production Center. Although strict realism may require a large amount of detail in distributing some charges, there must be a practical decision as to the required accuracy. As a result, some compromises are necessary to avoid spending more money on accounting than the resultant precision justifies.

The second step in the cost-control program is the establishment of standard costs for each Process Center. These standards should be realistic (i.e., attainable under proper conditions), flexible (i.e., providing for variations in scheduled rates of operation), and specific (i.e., sufficiently detailed as to avoid good performance in one part of the operation covering up poor performance in another). The easiest, but not necessarily the best, way to set standards is on the basis of past performance. If this method is selected, it is desirable to include enough history (at least one or two years) to get a reasonably precise average. Another method, often applied after the initial standards have been set on historical bases, is to apply critical studies to the work of each Process Center. Thus the chemical yield on a given operation may show an average performance of 92% of theory over an entire year's operation. However, laboratory studies may indicate that 98% is reasonably attainable. It is not sensible to set the latter figure as an arbitrary standard but it is worthwhile to use it as a goal for the future standard when the reason for low yields can be eliminated.

"Engineered standards" for operating labor may be developed by a study of the various operations within a Production Center. Astonishing inefficiencies are often uncovered by such studies. When better tools are found or better planning of work can reduce the number of men required, a standard can be set that is reasonably attainable yet substantially lower than that established from previous performance. The reduction of unit cost in the Process Center will measure the effectiveness of the studies and their application.

Standards for utilities must be developed not only for their production but also for their distribution to the Production Centers and for their use in those centers. The engineer in charge of utilities has available a great fund of information as to what should be his cost per 1,000 lb. of steam/kw. hr. of electric energy delivered to the bus bar, or 1,000 gal. of water pumped into the lines. He can also determine what is a reasonable line loss to the individual departments. Sometimes, however, a large discrepancy such as that between the main flow meter at the boiler house and the sum of the department meters is dismissed as the result of errors in the users' meters when there may be a faulty steam trap or bad insulation on the distribution lines. The cost of delivered steam or water or air is a standard that deserves attention.

For the use of utilities by the various Process Centers, standards may be developed from calculated requirements of the work to be done, checked where possible by actual measurement during reasonable test periods. Requirements for certain of these utilities vary with the weather as well as with rate of production. Thus, steam consumption for a given Production Center may be 25% greater in January than in July for the same tonnage production. Likewise, the use of cooling water on a given job may be markedly greater in summer than in winter because it requires more water at 75° F. than at 35° F. to effect the necessary cooling. One way to provide for this situation has been to develop curves which take into account both production activity and weather. Thus, a plot of pound steam per kilowatt hour as ordinates vs. degree days per month as the abscissae serves well as a variable budget standard. Similarly, cubic feet water vs. average water temperature per month serves equally well as a standard of water consumption. A somewhat similar method can be used for standards on refrigeration, air conditioning, and other quantities.

Maintenance standards for individual jobs may be based upon work-measurement studies. However, for a given Process Center, it is necessary to have over-all figures for standard man-hours and for repair material. These are usually based on past history, modified by judgment and opinion. Because the major need for maintenance comes from plant activity, the use of some measure of that activity as a common denominator of repair costs is to be recommended. In some cases, tons of production are satisfactory measures of activity, and in other cases, the best common denominator is energy consumption, expressed as kilowatt hours. Curves relating man-hours of maintenance labor to kilowatt hours of energy consumption often provide satisfactory standards for individual Process Centers or for a group of centers. If the curve relates to a whole building containing several Process Centers, the standard must then be allocated on a rational basis to the individual centers.

After standards of performance have been set up for each Process Center, the actual expenditures during each cost period (month or quarter) are then compared with the standards. Statistical studies have presumably been made to show how much deviation from standard is normal and should not require action; that is, only the abnormal variance in excess of the normal deviation

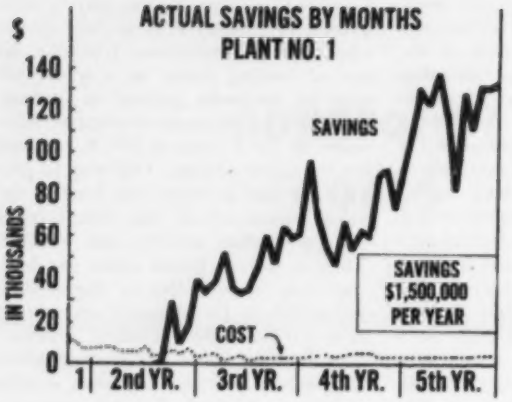


Fig. 1.

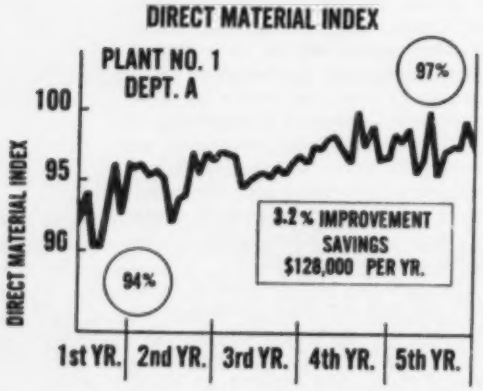


Fig. 2.

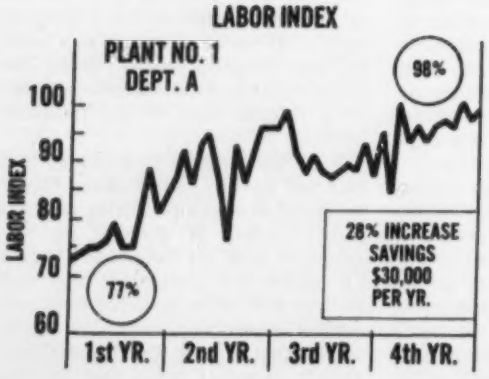


Fig. 3.

calls for corrective action. The interpretation of the variances and the prompt application of management's attention to the abnormal deviations make for success or failure of the cost-control system.

Briefly stated, successful cost control in production involves the selection of suitable Process Centers for production and for service departments, distribution of actual expenditures to all centers, redistribution of costs from Service Centers to Production Centers, establishment of realistic and flexible standards for all centers, and final action based upon intelligent interpretation of variation from standard wherever it occurs.

Some improvements effected by the proper installation and use of good cost-control systems in two plants are illustrated in the following paragraphs.

The accompanying illustrations give some actual results obtained by a chemical plant after its supervisory staff became more cost-conscious and the various departments coordinated to achieve certain cost-reduction goals.

Figure 1 shows typical actual plant savings by months as a cost-control installation progresses. These and other savings might be termed by an accounting department as an out-of-pocket savings basis. That is, they do not include fixed overhead or other apportioned costs.

The cost shown is typical of the added cost of setting up and administering a cost-control plan. This cost includes design of the plan, establishment and maintenance of standards, issuance of reports, analyzing of variances, making methods studies, issuance of written standard practices, and related activities.

It should be noted that the savings usually increase year by year as more departments are placed on cost-control standards and as the effect of the changes continues to accumulate.

During the first year, when the plan is being designed and the standards are being established, quite frequently few savings are made, and the program may be practically a total liability.

During the following years the results begin to show up, and savings should continue to accrue at an accelerating rate.

After two years of operation the monthly savings, in this typical case, are four times the monthly cost.

After three years of operation, nine times the monthly cost.

After four years of operation, twenty times the monthly cost.

By the end of the fourth year, the accumulated monthly savings, in this case, are at the rate of $130,000 per month, or $1,500,000 per year.

Because of the high value of materials, improvement in use of materials, or

yield of product, can result in large dollar savings, even though the percentage increase is small.

In the chemical industry savings of this type can be made usually in the production departments by attention to a number of different factors, such as the following:

(1) Increased attention to low yields and poor material utilization
(2) More effective staff assistance in analyzing and correcting causes of losses
(3) Reduction of many batch formulation losses due to
  (a) Use of excess material
  (b) Use of higher quality material than necessary
  (c) Use of material in more expensive form
(4) Reduction in mechanical losses such as:
  (a) Spillage, and other losses in mixing, grinding and packing

Further material savings can usually be made by

(5) Improving an ineffective building technical control organization when necessary to get better quality control during processing operations
(6) Rewriting of incomplete and obsolete process instructions to prevent operating errors
(7) Increase in batch sizes and length of production runs which reduces material losses in clean-up
(8) Process changes to improve the efficiency of the process
(9) Use of specifications for purchase of raw materials to prevent losses due to use of inferior materials
(10) Decrease in losses caused by reworking of off-standard material

Increases in material performance as shown in Figure 2 do not just happen. They are the result of a series of definite constructive steps taken by supervision, in order to obtain this improvement.

Typical examples of improvement in labor costs without the use of wage incentives are illustrated in Figures 3 and 4. In these cases, the index is based on the identical standards for the total period, in order to show the total improvement.

In the chemical industry labor saving without wage incentives can be obtained in a number of different ways.

(1) better training of personnel
(2) increased flexibility of operating crews
(3) increased work opportunity
(4) elimination of excess personnel
(5) changes in operating organization
(6) transfer of ineffective supervisory personnel
(7) improvement in operating methods
(8) use of labor-saving equipment
(9) larger batch sizes
(10) better planning and scheduling
(12) elimination of abnormal waiting and delays
(12) temporary transfer of idle personnel (to other necessary work)
(13) methods studies to reduce high labor content

Savings in expense are also possible. One's expense cost-control standards should help to lower various expense costs in certain departments. For example, in one chemical plant it was found that a decrease in filter-cloth usage in one department was possible. (See Figure 5.)

The improvement shown was due largely to: (1) decrease in usage caused by better control, and (2) changes in certain processing steps to eliminate some strong, hot acid and alkaline reactions.

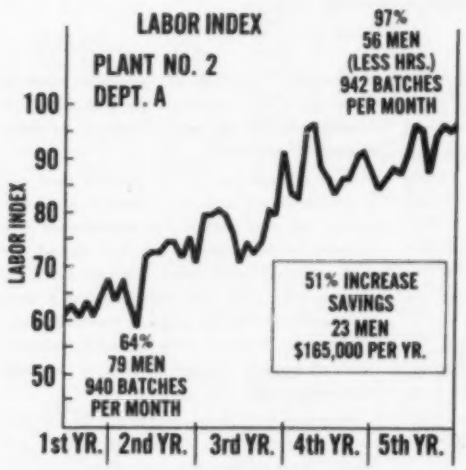


Fig 4.

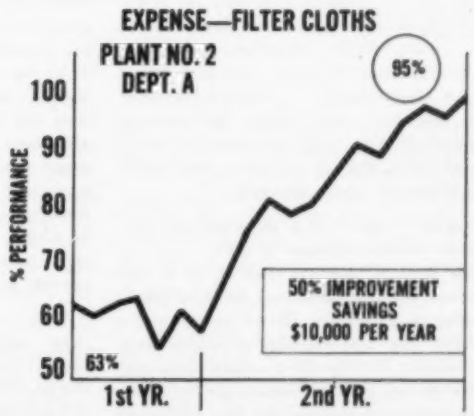


Fig. 5.

economics

The changes in processing steps just referred to were advantageous after it was realized that when standards were being set, a set of filter cloths lasted only about five charges on certain products.

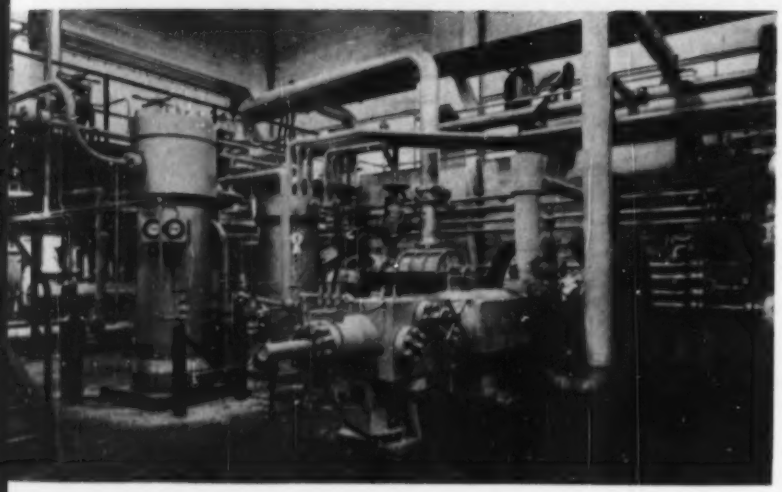
At a later period, (not shown on Figure 5), further improvement was made by the substitution of a filter cloth made of synthetic fibers.

How did these results happen? Simply stated, it was through *organizing for cost reduction.* Such organizing in any company requires the same planning and preparation that would attend a military attack against an enemy. And like a military action, the forces must be well organized, officered, and staffed with competent men.

It is however necessary that there be sufficient faith in such a program, in the minds of management, to give the work at least one year in which to begin to prove its worth. What management would not spend one dollar to make ten or more?

This program is just one important factor that separates the average company from one which leads competitively.

Presented at A.I.Ch.E. Springfield (Mass.) Meeting.



A portion of the synthesis loop showing the filter and separator vessels together with the low pressure blower supercharging H_2—N_2 mixture to the compressors, and the high pressure circulating pump which moves the gas around the synthesis loop.

which ammonia process?

A review of developments to aid management in deciding—*Editor*

C. O. Brown

Consultant, New York, N. Y.

Roughly forty years have passed since the production of ammonia by synthesis from pure gases was commercialized in Germany. Now, after four decades, one can say that synthesis processes have changed only a negligible amount. Immediately after Haber's work became known, several other synthesis systems were invented which attempted to avoid prior patent limitations. This fact accounts for the strange differences in working pressure between one system and another with ranges from 50 to 1,000 atm. Claims to novelty and other advantages were put forth by Haber, Bosch, N.E.C. (Nitrogen Engineering Co.), Casale, Claude, Fauser, and others, all engineers of some repute. Nevertheless, when one examines those processes which are now in active use, the general statement holds that a remarkably small difference is found in the synthesis equipment of the corresponding systems today. One may go further and say that all systems are moving toward a standard design of the N.E.C. type, especially the 1,000 atm. processes.

Certain circumstances surrounding the early days of ammonia synthesis are worth recording. Le Chatelier first announced the conditions under which hydrogen and nitrogen combine, but it was the careful, intensive researches of Fritz Haber which put accurate values on the equilibrium conditions and showed the reversibility of the reaction. During this work Haber was secretly excited with the idea that he had a really new process by which ammonia could be produced commercially in unlimited quantities, but as the work drew to an end, he reluctantly decided that the only practical commercial program resided far within a field of impossible and extraordinarily high pressures and high temperatures.

Carl Bosch of Badische Co. had no such inhibitions, and, aided by his knowledge of engineering and chemistry, he made Haber's research into a miracle of success. His work initiated the production of bulk hydrogen in a pure state, which is the basic and costly item in ammonia production.

Nitrogen, also important, is never an item of any concern costwise; it is always drawn from the atmosphere around the earth. When supplied with pure hydrogen and nitrogen, one can easily make ammonia from simple equipment. In Haber's researches fundamental equipment was used (Figure 1) which is still the keel of all processes called by whatever name one will.

Figure 1 shows (1) a multistage gas compressor which compresses a pure mixture of three parts H_2 and one part N_2 to a high pressure, and which discharges the gases without cooling to a converter (2) for contact with a catalyst after heat exchange of reaction heat. An amount of ammonia is formed, depending upon the conditions of temperatures and pressure. After such formation the gases are cooled in condenser (3), and the ammonia which is liquefied is then separated in trap (4). The residual gas with its small amount of ammonia escapes condensation.

Since a large part of the valuable pure gas is not converted and also contains some ammonia, the next step in the development was recovery of these gases. This was carried out in the original small Haber plant by scrubbing the gas with water and then recycling it back to the inlet of the last stage of the compressor.

Shown in Figure 2 is the commercial adaptation of Haber's equipment with a separate circulating pump.

Here again (1) is a compressor, (2) the converter and catalyst, (3) a water-cooled gas cooler, (5) a water absorber which scrubs the gas picking up practically all the ammonia made, (6) a recirculating pump which raises the pressure of the compressed gas above the main line pressure and thus returns and reintroduces it to the system ahead of the catalyst. In operation this process emphasized the fact that there are inert gases in the nitrogen from the atmosphere, especially appreciable amounts of argon which, of course, would not make ammonia and which just accumulated in the synthesis loop. The concentration was controlled by purging a small part of the loop gas ahead of the recycle pump. Average conditions of the synthesis are also shown in Figure 2.

When the Oppau plant was built, many *refinements* were added to the simple process of Figure 2, as shown in Figure 3.

Engineering judgment indicated the

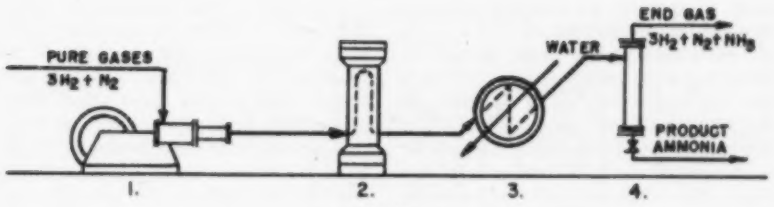


Fig. 1.

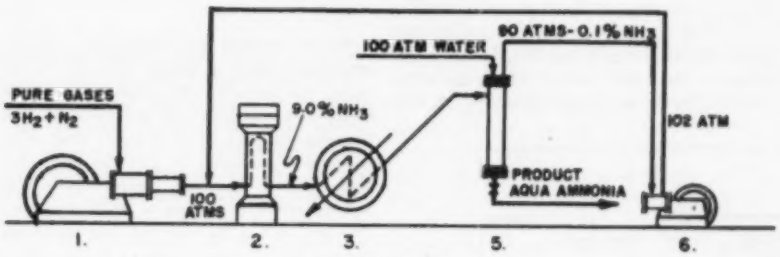


Fig. 2.

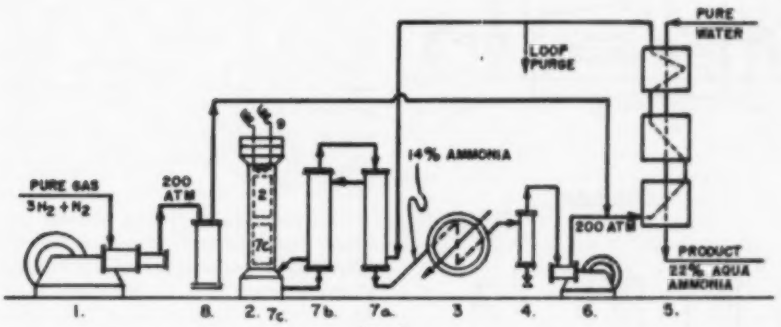


Fig. 3.

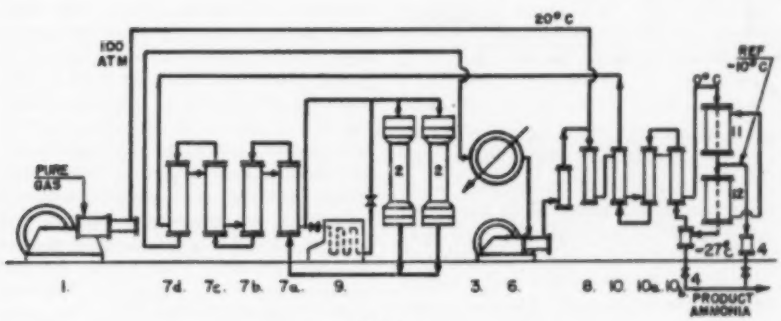


Fig. 4.

need of dozens of *separator* vessels, duplicate pipe lines on all hot- and even warm-gas streams with hundreds of valves, so that any run of pipe could be replaced while in full operation, and finally a better recovery of heat effected.

The pure gas was cleaned further of lube oil by filter (8), the converter was equipped with an electric resistance heater (9) for starting and a gas-to gas-heat exchanger (7c), is shown, in addition to the catalyst cooling tubes.

Two heat exchangers (7a) and (7b) were placed in series with (7c) but in separate outside pressure vessels. The catalyst converter was 36 in. O.D. by 20 in. I.D. and 40 ft. 0 in. inside the ends. A catalyst mass roughly 20 in. in diam. by 20 ft. long produced 20 tons of ammonia a day. Present practice in the United States results in the production of 75 tons in a mass 24 ¾-in. diam by 21 ft. long, with cooling tubes in the catalysts. Pressure bottles are used liberally between important pieces of equipment for balancing.

The early development of ammonia in the United States placed great importance on the production of anhydrous ammonia. It was assumed that transportation costs would be much less for anhydrous, and, since all anhydrous was painstakingly made from aqua, it commanded a much higher price. Hence, the early plants were designed to use refrigeration on the converted gas and to recover liquefied anhydrous ammonia, as shown in the accompanying Figure 4, for an early commercial plant in the United States.

This plant operated at 100 atm. pressure, with semiwater gas made from coke as the source of pure hydrogen and nitrogen. The entire design was worked out in a masterly manner, and every contingency was provided for by American engineers under the leadership of W. H. Knishern.

The flow diagram (Figure 4) is somewhat extensive, but this successful plant was the basis of the United States fixed nitrogen industry.

In this system the pure make-up gas at 100 atm. entered an oil filter (8) in the circulating loop, mixed with the circulating gas, and went through the high side of the three heat exchangers (10, 10a, and 10b), which cooled it to 0° C. It was then intensively cooled to 10° C., (11) and to −27° C. (12) with product ammonia separated out after each cooler in 4,4. The

stripped gas then passed through the low side of the three heat exchangers, which raised the temperature to 20° C. Then it was warmed by heat exchange in four tubulars (7a, 7b, 7c, and 7d) to enter the catalyst cooling tubes directly at 400° C. A gas-fired coil heater (9), was used just before the catalyst cooling tubes with safety, efficiency, and success. After catalysis the gas was returned through the four heat exchangers, passed into a final water cooler (3), and then into the circulator. This system, controlled by a large chemical company, has made a great deal of ammonia and compares favorably with N.E.C., the first commercialized process in the States and developed with an intensive application of modern principles of chemical engineering. It far outstripped most other processes in application. Improvements in custom-built, or specially designed plants have continued up to the present time by leading consultants. A typical flow diagram is shown in Figure 5.

The pure gas enters the filter (8), mixes in this vessel with loop gas. The mixture passes to a single "cold" exchanger then to a refrigerated cooler by evaporation of the product, or any part of it as desired, through the cold side of cold exchanger (10), and into the 350 atm. converter. Here heat-exchange cooling of the catalyst, and starting heat are all provided for. The converted gas leaves the converter at only 180° C. Most of the ammonia is recovered by

cooling with water (3), then by separating the liquid ammonia, after which the gas enters the circulating compressor (6) and is pumped into filter (8) for purpose of recycling.

Important points underlying the preference for this system are: the increase in synthesis pressure to 350 atm., the heat exchange inside the converter with starting heater following the catalyst cooling tubes, and the water-cooled and ammonia-cooled condensers.

As mentioned before in this paper, development of processes at high pressure went along simultaneously. Since many of the developments in these higher pressure processes have been based upon expediency and compromise, the trend can be followed by reviewing one which uses the highest pressures of 1,000 or more atm. In starting off it is well to remember that, before being approved for this service, all equipment and vessels must be tested hydrostatically to 1,500 atm. (22,000 lb./sq.in. gauge). A synthesis pressure of 1,000 atm. casts little credit on the splendid ammonia synthesis catalysts available today. Some of the other advantages one might expect from such extremely high pressures must be qualified because of departure of the gas mixture from ideal gas laws, the greater solubility of pure gas in the product ammonia, and through the use of much smaller manufacturing units having, larger leakage losses. Today much better alloys and other materials of construction make the use of 1,000 atm. more practical than was the case when the designs were first developed. Even today the very high pressure systems are of doubtful wisdom because the units must be kept small, though the trend in size of units has passed 150 tons per day and is soon to be 200 tons per day or more. *Smallness* has always been the prime claim for merit for all the equipment of the 1,000 atm. process, but today this is something of a drawback because of the competition among plants, the capacities of which range from 200 tons of ammonia daily to more than 400 tons. The second universally publicized claim to superiority of the 1,000 atm. process was the belief that an iron catalyst could perform efficiently on an impure gas; thus this would save the cost of expensive purification processes.

This saving is not so apparent when such factors are balanced as the actual performance of the catalyst, and all other cost items from the higher compression, increased maintenance, and higher charges for small units. The early commercial plants used catalytic converters 4 in. I.D. and 7 ft. long.

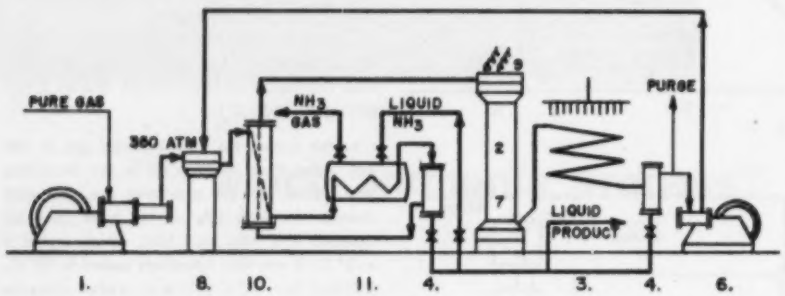


Fig. 5.

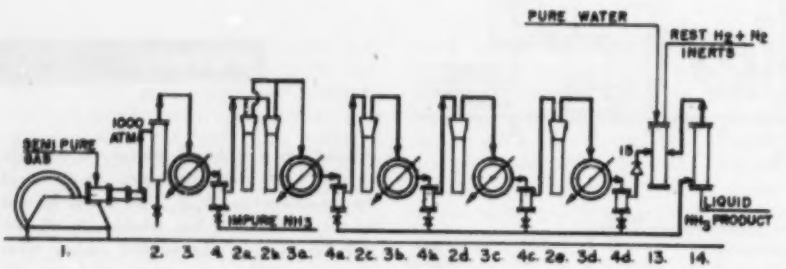


Fig. 6.

Six such converters were arranged in a series-parallel connection to make 7½ tons of ammonia per day. The total weight of the six converters was just over 4 tons (1). At first the catalyst being used with impure gas lasted only a few days. More recently the time has been extended from 20 to 58 days, especially in those plants which, for reasons of economy and practicality, require the changing and reducing of catalysts in 20 to 24 hr. By contrast the large converters and catalyst, designed by the writer, have been run for 2,800 to 2,900 days and then have been serviced in five days.

It is believed the advantage is definitely in favor of 350 atm. synthesis pressure. It appears that the sponsors of the superpressure 1,000 atm. processes also believe this as they have steadily decreased the synthesis pressure until, at this writing, the Claude process is offered at 540 atm. It is expected that it will soon be down to 350 atm. The arrangement of the Claude converters for 1,000 atm. was originally as shown in Figure 6 (*2*).

Partially purified gas, compressed in hypercompressors enters a catalyst converter (2) directly. The converted gas is cooled (3), the ammonia is separated (4), the gas going to series converters (2a and 2b) in parallel after which ammonia is separated in (4a); the gas enters series converter (2c), with after-cooling in (3b) and separating in 4b, then to similar converters (2d—2e), cooling (3c and 3d), and separating (4c and 4d). The gas is reduced to atmospheric pressure and all ammonia condensed out or absorbed by water in (13), while the liquid ammonia product is being reduced to 200 lb./sq.in. gauge and degasified in (14). The released gas carrying a large percentage of ammonia is also scrubbed (13). The uncombined gas carries a small percentage of inert gas, and, although the yield of ammonia was relatively low, this gas was degraded to a low heat content fuel use.

This old Claude process had an unhappy and shortlived existence, and on the second revamping with U. S. trained chemical engineers contributing their knowledge, it appeared as a 1,000 atm. version of the process developed by the U. S. Government at the Fixed Nitrogen Research Laboratory (*3*). These engineers also drew heavily on all successful low-pressure practices. In Figure 7, a guard converter (16), received all the make-up gas, combined some to a small amount of ammonia and, by reaction, absorbed or reduced all the original impurities in the make-up to a lower value. These impurities were partially removed by cooling and separation. Next a real section of all low-pressure processes was inserted in its entirety into the now modified system of Figure 6. This was done by adopting a circulating loop with a standard circulating pump. This was a curious modification because the unnecessary 1,000 atm. synthesis pressure was retained.

Again referring to Figure 7, one sees (1) as the hypercompressor delivering partially purified gas at 1,000 atm. to guard converter (16). The next steps consist of the water cooling (3a), and separation of ammonia and other condensables (4a). The loop is quite standard. The gas after contact in (2) is cooled (3) and is separated from product ammonia (4), and pumped back to converter by circulator (6). The special equipment, unique for these high pressures, degasifies the product and collects the

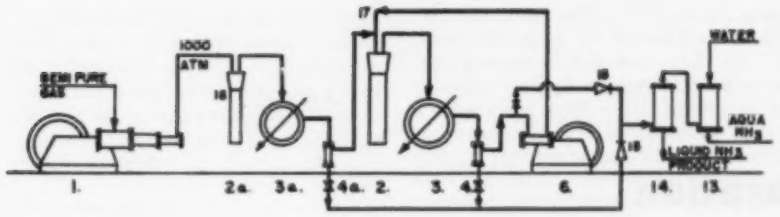


Fig. 7.

ammonia vaporized as aqua liquor. If the condensate from (4a) is to be kept separate, the degasification unit and valves must be duplicated. The need today is for reduced capital costs, which in the last analysis means elimination of equipment. It is now difficult to do this as the engineers of the N.E.C. system have developed the standard loop of that system to near perfection, costwise. For large plants the writer has proposed a two-converter, one-circulator synthesis system, which makes a further equipment saving, although for small plants such a system is not economical. The use of two converters to do the work of one must be avoided, but where the plant capacity reaches 200 to 400 tons/day, all possible economies are combined in a loop arrangement shown in Figure 8 as follows: Gas circulates over catalyst (2), ammonia is removed (4), volume is restored by fresh make-up gas, the mixture circulates over (2a), ammonia is removed, the volume is restored, and the mixture enters the circulator, then circulates over (2) again. Either converter can be used alone.

In most plants the product can be recovered by the use of water only, and in many cases, the two condensers are combined into one installation. Several innovations, and accessories have been added to the loop of some high-pressure processes to increase the justification and advantages of the high pressures. The most interesting of these devices is the use of an injector in place of a positive piston pump to circulate the loop gases. Studied by U. S. engineers in 1928, the injector was found to be entirely unsuited for a 300-atm. process. At 1,000 atm. it has some unusual characteristics. Built much like the old, and now becoming an obsolete steam injector, it has no moving parts, is low in first cost, and requires little room and no foundations. Usually it is placed in the loop where the make-up gas enters as at (17) (Figure 7). Here the favorable comparisons end. Injectors, of course, do not work without an expenditure of energy; in fact they require a great deal of energy which must be supplied by the main compressors. The author voices a strong objection to use of injectors. It is always difficult to get compressors large enough for the big capacity loops now used, and it cuts the effective capacity of any compressor to serve also as a circulator. The efficiency of a steam injector as a pump is approximately 1.8 to 2.0% under favorable conditions, but the thermal efficiency is of the order of 96 to 99%. With dry synthesis gas containing no condensables, the efficiency is not more than 1%, but falls appreciably at part loads. The injector lacks ability to overcome appreciable heads. It is advantageous to design loops with 600 to 700 lb./sq.in gauge resistance to flow. This is efficiently handled by a mechanical pump, but is beyond the range of an injector. After a review of the preferred operating program of several well-run plants it can be said that the change in space velocity from one part of the day to another is considerable, and it is important to know accurately what that change is. This is not easily determined with an injector. It may be stated here that injectors are used more in Europe than in the United States.

Electric resistor starting heaters have always been used on the very high-pressure systems. The German Haber plants used a high-pressure hydrogen-oxygen burner directly on the catalyst in the earlier plants, and later changed to an inside electric resistor heater. Most low-pressure plants now use inside electric starting heaters, although some still use an outside gas-fired coil heater, which has been greatly improved and reduced in cost. Since the heater is used so little, some designers—and the writer too— prefer to have a device which can be cut off when not in use; such a device avoids the insulated packed joints through the converter shell or head. The electric heater inside the converter can be used at low production rate to augment reaction heat, and furnish a degree of control.

The preferred catalyst used by all plants for thirty-five years or more has been the doubly promoted iron combination, loaded as iron oxide and reduced in place. A considerably improved quality can now be purchased freely from a United States firm in excellent packages at the low price of 59 cents a pound. It has good physical form, high activity, and is properly reduced in 75 to 80 hr. The advantages of this last factor are not appreciated by many plant managers. During reduction the entire plant charges, at approximately maximum depreciated cost, must be absorbed by production. It is apparent that any catalyst requiring 215 to 220 hr. to reduce must have some considerable advantages to offset the increased cost of reducing. The expenses of a plant producing 100 tons of ammonia daily will amount to approximately $150 to $155/hr.; therefore, a catalyst with slow-reduction characteristics, and requiring an extra 140 to 145 hr. must have a $21,800 advantage. There is no such catalyst available.

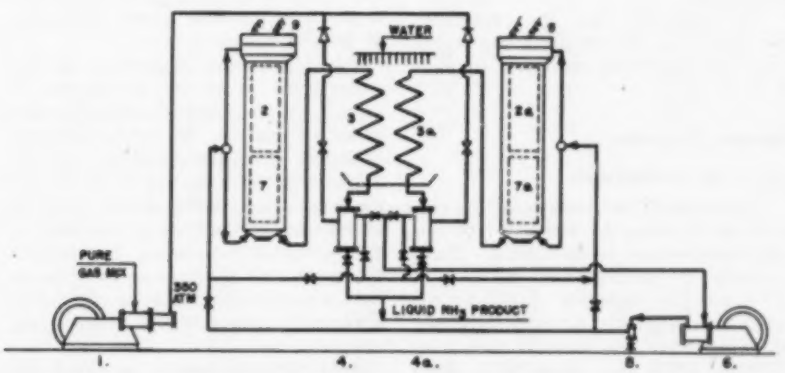


Fig. 8.

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membrane separation

in the gaseous phase

Karl Kammermeyer and David William Brubaker

State University of Iowa, Iowa City, Iowa

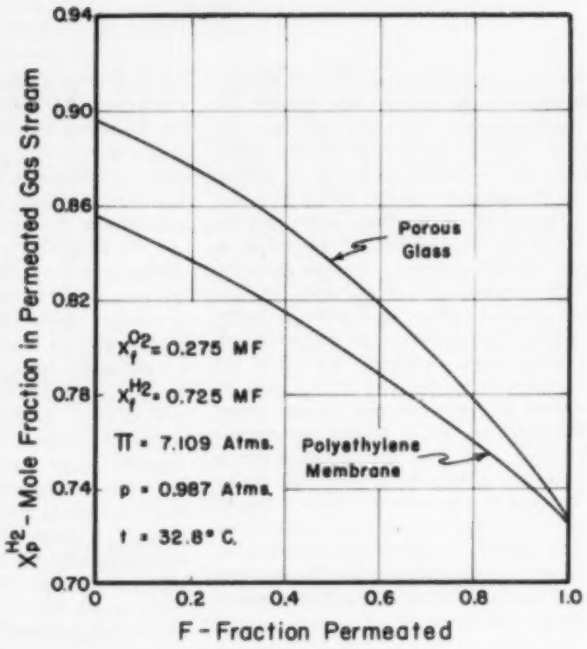


Fig. 1. A comparison of separation for the system H_2—O_2

The continuous separation of gaseous mixtures by fractional diffusion through membranes seems destined to become one of industry's basic separation operations. The importance of this principle has already been demonstrated by its use in the Oak Ridge diffusional process. Although the material of construction used by the Atomic Energy Commission is reported to be metallic (*7*), there are literally hundreds of different materials, both porous and nonporous, which ultimately will be investigated and may be used as barriers for the separation of gaseous mixtures.

This paper compares the results obtained on two different types of porous membranes with those obtained on nonporous plastic membranes. The porous membranes include samples of both porous glass (an intermediate in the manufacture of Corning's Vycor) and an experimental ceramic membrane fabricated by the Selas Corporation of America. The porous glass is characterized by relatively uniform pores, reported to have diameters from 20 to 60 Å with a mean diameter of about 40 Å.; the ceramic membrane has a much wider range of pore sizes. Thus, the porous glass membrane will exhibit only Knudsen flow, but the ceramic membrane will exhibit both Knudsen and Poiseuille flow at pressures and temperatures at or somewhat above standard conditions. The characteristics of plastic membranes may be typified by a polyethylene membrane. Although the direction of separation and the quantity of gas flow on each type of plastic membrane differ, the range of results obtained on any one membrane is about the same order of magnitude.

The apparatus and the procedures used to obtain data on these membranes have been described previously (*3, 4, 5, 6, 8, 9*).

Gas-Gas Separation

EFFECT OF TEMPERATURE

The effect of temperature on the separation of gases by means of porous glass membranes is very small. Theoretically the permeability varies with $T^{0.5}$ and the variation should be the same for all gases. Actually, however, the exponent T was found to vary from 0.500 to 0.525 (*6*); therefore a slight change in separation is caused by changes in the ratio of the permeability constants. Since the ratios of the permeability constants for gases are affected only by the difference in the value of the exponents of the temperature, no appreciable change occurs in the separation over a moderate temperature range. The effect of temperature on separation for porous ceramic membranes is more pronounced and results from the fact that the flow is dependent upon changes in viscosity in addition to the direct effect of temperature. This change can be predicted, however, since an equation of flow is known.

The temperature dependence of the permeability of plastic membranes on gases has already been discussed in some detail (*2* and *4*). As the temperature coefficient of the permeabilities vary for different gases, increasing or decreasing the temperature will generally result in an increase or decrease in the ratio of the permeability constants. If this ratio decreases with an increase in temperature, a compromise has to be established between the use of higher temperatures

David William Brubaker is at present with Chemstrand Corp., Pensacola, Fla.

to obtain higher permeabilities and lower temperatures to obtain higher selectivities; however, when the selectivity increases with an increase in temperature, the only temperature restrictions are the physical characteristics of the particular plastic material.

EFFECT OF PRESSURE

The effect of pressure on separation for both the porous and the plastic membranes is such that an increase in the pressure differential, Δp, results in an increase in the separation. If the downstream pressure is zero, however, the effect of pressure will cancel, and hence pressure will have no effect on separation. If the low pressure has a finite value greater than zero, then the total pressure terms will not cancel and pressure will affect the separation. If the high pressure is increased while the low pressure remains constant at some value greater than zero, then the degree of separation also will be increased. However, if the low pressure also increases, then the result may be an increase, a decrease, or no change in the degree of separation. The limit to which the pressure differential may be raised is determined by the physical strength of the membrane and the relative economics of compressor requirements.

EFFECT OF MOLECULAR WEIGHT

The effect of the molecular weight of the gas is not the same for the porous and non-porous membranes. The separation could be predicted for the porous glass membrane with reasonable accuracy by using the square root of the molecular weights of the gases. If the viscosity of the gases is considered, the separation can be determined for the ceramic membrane with a fair degree of accuracy from the molecular weights. For the plastic membranes no correlation is possible between the molecular weight of the gas and the separation characteristics. This lack of a correlation is due, of course, to the complexity of the flow mechanism for plastic membranes.

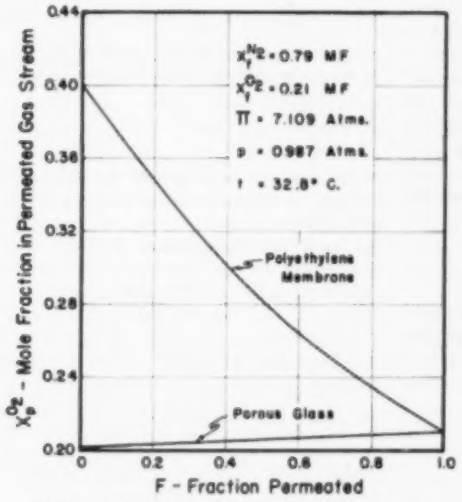


Fig. 2. A comparison of separation for the system N_2—O_2

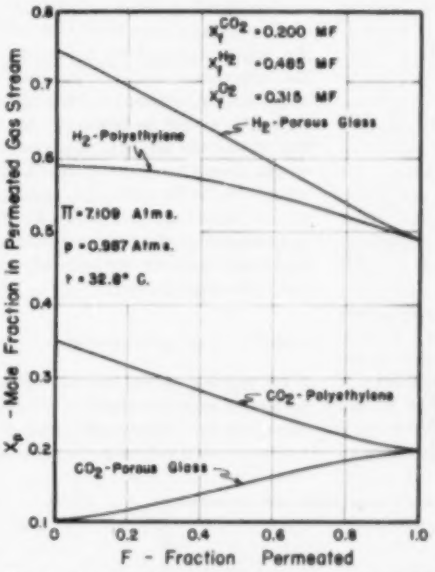


Fig. 3. A comparison of separation for the system CO_2—H_2—O_2

Table 1.—A Comparison of the Area Requirements for the Separation of a System Containing H_2 — O_2 by Means of Polyethylene or Porous Glass Membranes

G_f = one g.-mole of feed gas/min. Temperature = 32.8° C.
$X_f^{H_2}$ = 0.725 mole fraction π = 7.109 atm. abs.
$X_f^{O_2}$ = 0.275 mole fraction p = 0.987 atm. abs.

	G_p	Porous Glass Membrane		Polyethylene Membrane	
F	moles/min.	$X_p^{H_2}$	Area-cm.^{2}	$X_p^{H_2}$	Area-cm.^{2}
0	0	0.895	0	0.855	0
0.2	0.2	0.876	0.128×10^4	0.836	6.51×10^5
0.4	0.4	0.850	0.268	0.814	13.18
0.6	0.6	0.817	0.428	0.788	20.65
0.8	0.8	0.777	0.624	0.759	28.61
1.0	1.0	0.725	0.845	0.725	37.56

	G_p(g.-moles/min.)		Area (cm.^{2})	
$X_p^{H_2}$	Porous glass membrane	Polyethylene membrane	Porous glass membrane	Polyethylene membrane
0.840	0.47	0.17	0.315×10^4	5.90×10^5
0.820	0.59	0.36	0.415	12.10
0.800	0.70	0.52	0.524	17.45
0.780	0.79	0.67	0.610	23.25
0.760	0.88	0.80	0.705	28.61
0.740	0.96	0.93	0.795	34.75
0.725	1.00	1.00	0.845	37.56

EFFECT OF MEMBRANE

In specific instances either the porous or the plastic membrane may give a greater separation, and different plastic membranes may vary widely in their selectivity towards a given gas mixture, consequently, for any specific separation actual separation data are needed. Usually the constituents which have molecular weights of nearly the same value can best be separated through use of plastic membranes.

Figures 1 to 3 compare the separation obtainable on a polyethylene film and a porous glass membrane. A greater degree of separation is possible for the H_2-O_2 mixture if the porous glass membrane is used. Almost no separation is obtained for the N_2-O_2 mixture with the porous glass membrane, but a rather large separation is possible with the polyethylene membrane. The direction of separation, however, is opposite on the two types of membranes for the N_2-O_2 separation. For the three component system shown in Figure 3 both

material separation

Table 2.—A Comparison of the Area Requirements for the Separation of a System Containing $N_2 - O_2$ by Means of Polyethylene or Porous Glass Membranes

G_f = one g.-mole of feed gas/min. Temperature = 32.8° C.
$X_f^{N_2} = 0.790$ mole fraction $\pi = 7.109$ atm. abs.
$X_f^{O_2} = 0.210$ mole fraction $p = 0.987$ atm. abs.

		Porous Glass Membrane		Polyethylene Membrane	
F	G_p moles/min.	$X_p^{O_2}$	Area-cm.^{2}	$X_p^{O_2}$	Area-cm.^{2}
0	0	0.202	0	0.400	0
0.2	0.2	0.203	0.322×10^4	0.348	0.312×10^7
0.4	0.4	0.205	0.644	0.300	0.648
0.6	0.6	0.207	0.966	0.263	0.966
0.8	0.8	0.209	1.288	0.234	1.376
1.0	1.0	0.210	1.61	0.210	2.190

the degree and the direction of separation are different with the two types of membranes. Thus the problem of finding the ideal membrane for the particular separation is even more complex.

A comparison of the rates of gas flow from the permeated, that is, downstream, side of the membrane for H_2-O_2 and N_2-O_2 shows that the permeability through the porous glass membrane is approximately one thousand times as great as in the case of the polyethylene film. Thus the area requirement a cell would be much less for the porous glass membrane. A comparison of the areas for these membranes for a particular separation is shown in Tables 1 and 2. The porous ceramic membrane is about thirty times more porous than the porous glass membrane, and thus the area requirement for similar separations would be even less. At higher pressures, however, where the separation obtained on the ceramic membrane is reduced, additional separation cells would be required. Of course, the cost of the membrane and of the cell would have to be considered, and the membrane with the least area requirement would not necessarily be the most economical. Ceramic membranes, which require a greater recycle, increase the cost of compression.

PREDICTION OF SEPARATION

For both the organic and the inorganic membranes the equations presented for determining separation from permeability data (5 and 9) provide accurate and satisfactory predictions.

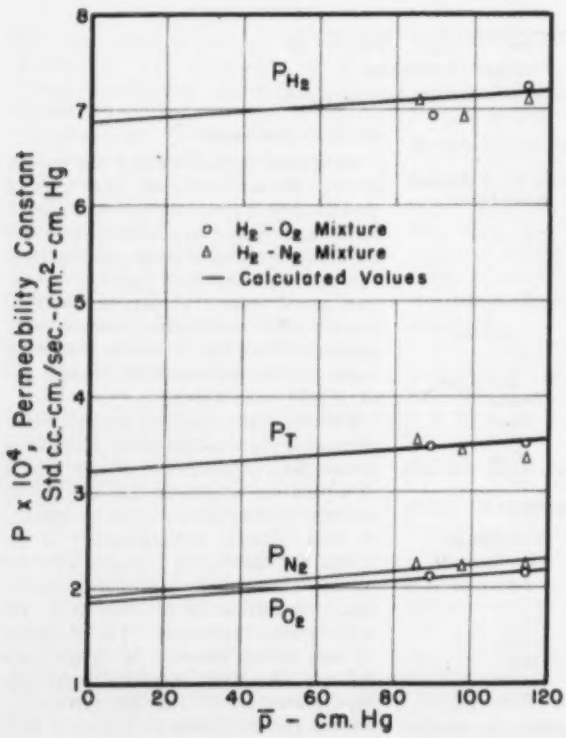


Fig. 4. Permeability through porous media-mixed flow.

The total rate of flow from the low pressure side of the membrane may be correlated at a given temperature by means of the following equations:

for porous ceramic membranes

$$(N_p)_T = \frac{b'p'(\pi - p)}{\eta_M} + \epsilon'\left[\frac{(\pi X_o^A - pX_p^A)}{\sqrt{M_A}} + \frac{(\pi X_o^B - pX_p^B)}{\sqrt{M_B}}\right] \quad (1)$$

for porous glass membranes

$$(N_p)_T = \epsilon'\left[\frac{(\pi X_o^A - pX_p^A)}{\sqrt{M_A}} + \frac{(\pi X_o^B - pX_p^B)}{\sqrt{M_B}}\right] \quad (2)$$

for plastic membranes

$$(N_p)_T = P_A(\pi X_o^A - pX_p^A) + P_B(\pi X_o^B - pX_p^B). \quad (3)$$

The value of the resulting permeability constant can be obtained in the following manner:

$$P_T = \frac{(N_p)_T}{(\pi - p)} \quad (4)$$

The rate of flow of each of the constituents through the membrane can be obtained by the following expressions:
for porous ceramic membranes

$$(N_p)_A = X_p^A(N_p)_T = \frac{b'p'}{\eta_M}(\pi X_o^A - pX_p^A) + \frac{\epsilon'}{\sqrt{M_A}}[\pi X_o^A - pX_p^A] \quad (5)$$

for porous glass membranes

$$(N_p)_A = X_p^A(N_p)_T = \frac{\epsilon'}{\sqrt{M_A}}(\pi X_o^A - pX_p^A) \quad (6)$$

for plastic membranes

$$(N_p)_A = X_p^A(N_p)_T = P_A(\pi X_o^A - pX_p^A) \quad (7)$$

Equation (1) is a general expression for the flow of gases through a porous membrane in which mixed flow is present. As such it represents a new modification of the relationships presented by Adzumi (1) and by Kammermeyer and Ward (10). The essential difference between Equation (1) and the Adzumi equation is that the effects of the fraction permeated and separation are accounted for directly, but Adzumi's equation does not do this. Equation (1) is similar to Kammermeyer and Ward's except that it is more inclusive since it is a general equation and their equation is applicable only over a small range of variables. If the flow through porous media is entirely molecular, then the slope of the line resulting from a plot of the permeability, P, versus the average pressure, p', will be zero, and thus the term containing p' will become equal to zero; on the other hand if the flow is entirely laminar, then the other term will become equal to zero. In the first case the resulting equation will be identical to that of Knudsen (11) and in the second case an

equation similar to that presented by Poiseuille will result. Equation (2) is a statement of the first case. The difference between this equation and Knudsen's equation lies in the fact that Equation (2) takes into account the effects of the fraction permeated as well as of the separation obtainnd. Figure 4 shows the agreement between the experimental results and the calculated values based on these equations for a ceramic membrane.

A comparison of the ideal separation obtainable on the various porous membranes with the theoretical value predicted by Graham's Law, is given in Table 3. The value of the ratio α is very close to the theoretical value in every case for the porous glass membrane with the real gases. However, this is true only at low pressures for the ceramic membranes.

Gas-Vapor Separation

EFFECT OF TEMPERATURE AND PRESSURE

The effect of temperature and pressure on the separation by means of porous glass membranes of mixtures containing both gases and vapors is large. Not only are the permeability constants affected to a much greater extent than are those for the separation of gases, but the actual separations are also affected. In general, the lower the operating temperature or the higher the upstream pressure the greater the deviation from values predicted by the equations used for gas-gas systems. This is not surprising since the effect of adsorption, which appears to be present when vapors are included, would be expected to increase as the temperature is lowered, and/or the pressure increased. At conditions of constant temperature an increase in the pressure differential may result in an increase or a decrease in the separation depending upon the adsorption characteristics of the particular vapor. Changes in the pressure differential across the membrane as well as a change in the pressure on either the upstream or the downstream side of the membrane at conditions of constant temperature and constant pressure differential, result in a change in the separation obtained.

The effect of temperature on the porous ceramic membrane is similar to that observed for the porous glass membrane. Although adsorbed flow is present, it does not appear to have much effect in comparison with the laminar flow through the larger capillaries.

As far as the plastic membranes are concerned, the effects of temperature and pressure on gas-vapor mixtures are the same as those on gas-gas mixtures.

EFFECT OF MOLECULAR WEIGHT

A correlation between separation obtained and the molecular weights of the vapor and gases cannot be postulated for either the porous or plastic membranes. The occurrence of adsorbed flow accounts for this in the case of the porous membranes, and adsorption or solution phenomena account for it in the case of the plastic membranes.

EFFECT OF MEMBRANE

Somewhat different separation characteristics are observed when different porous membrane samples are used. The separation obtained with plastic membranes, especially nonplasticized films such as polyethylene, does not seem to be affected appreciably when different samples of the same type of film are used. The separation obtained with plasticized plastic membranes, however, is greatly affected when different film samples are used.

PREDICTION OF SEPARATION

The results of experiments using gas-vapor mixtures with porous membranes do not give good agreement between experimental values and values calculated from the permeability data. In the most extreme case there is actually a change in the direction of separation at different conditions although the direction of separation predicted from permeability data does not change. The agreement between experimental and calculated results improves as the temperature of the mixture is raised, and/or the upstream pressure decreased. The closer the vapor approaches the condition of a condensable vapor, the greater is the deviation between the calculated and the experimental values.

For separations on plastic membranes with gas-vapor mixtures the experimental results agree quite well with the values calculated by use of actual permeability data.

A relationship which will predict the rate of flow from the downstream side of the membrane has not yet been obtained for flow through either porous glass or porous ceramic membranes. Any relationship which will be acceptable must include apparently at least three terms, that is, one term to predict each of the types of flow present. Such an equation is necessarily complicated and will depend largely upon the variables affecting adsorption.

The flow through plastic membranes may be predicted by using Equation (3). Good agreement is found between experimental values and the results obtained from this relationship.

Table 3.—A Comparison of the Ideal Separation Efficiencies of Porous Membranes at 25° C. for Various Binary Gas Mixtures *

Gas mixture	Ideal $(M_2/M_1)^{1/2}$	Porous glass Number I $\alpha = K_1/K_2$			Porous glass Number II $\alpha = K_1/K_2$			Porous glass Number III $\alpha = K_1/K_2$			Porous ceramic $\alpha = K_1/K_2$		
		$p' = 0$	$p' = 1$	$p' = 2$	$p' = 0$	$p' = 1$	$p' = 2$	$p' = 0$	$p' = 1$	$p' = 2$	$p' = 0$	$p' = 1$	$p' = 2$
H_2—O_2	4.00	3.68	3.68	3.68	3.41	3.41	3.41	3.65	3.65	3.65	3.24	3.27	3.27
H_2—N_2	3.74	3.42	3.42	3.42	3.185	3.185	3.185	3.45	3.45	3.45	2.50	2.94	3.25
H_2—CO_2	4.69	3.16	3.16	3.16	4.71	4.57	4.507	.....	.....	.....	4.23	3.51	3.10
H_2—He	1.414	.....	.....	.....	1.335	1.335	1.335	1.405	1.405	1.405	.....	.....	.....
N_2—O_2	1.069	1.075	1.075	1.075	1.068	1.068	1.068	1.055	1.055	1.055	1.29	1.115	1.035
O_2—CO_2	1.170	0.857	0.857	0.857	1.338	1.300	1.282	.....	.....	.....	1.305	1.04	0.920
H_2—NH_3	2.915	.....	.....	.....	3.765	3.556	3.200	.....	.....	.....	7.35	7.90	8.55
H_2—SO_2	5.657	.....	.....	.....	4.923	3.200	1.778	.....	.....	.....	.....	.....	.....
H_2—CH_4	2.828	.....	.....	.....	2.70	2.70	2.70	2.31	2.31	2.31	.....	.....	.....
† H_2—C_2H_4	3.740	.....	.....	.....	3.265	2.991	2.735	.....	.....	.....	.....	.....	.....
† H_2—C_2H_6	3.870	.....	.....	.....	4.103	3.951	3.678	.....	.....	.....	.....	.....	.....
† H_2—C_3H_8	4.690	.....	.....	.....	4.00	3.368	3.200	.....	.....	.....	.....	.....	.....
† H_2—C_4H_{10}	5.380	.....	.....	.....	4.267	2.065	2.060	.....	.....	.....	.....	.....	.....

* Note: All values of α are based upon ratio of K of pure components.

† In part from data (6 and 9).

Vapor-Vapor Separation

EFFECT OF TEMPERATURE AND PRESSURE

Superheated vapors have been observed to approach the characteristics exhibited by gases as the operating temperature approaches the critical value. For conditions of constant pressure, the separation is found to decrease as the vapors passing over the membrane are superheated. Better separation is observed, however, when the operating temperature approaches the saturation temperature (8). In a like manner as the upstream pressure approaches its saturation value better separation is observed, and conversely, the separation is decreased when the upstream pressure is reduced. An increase in the separation resulting from a decrease in the downstream pressure indicates that the best operating conditions occur at low upstream pressures, at saturation temperatures, and at low values of the fraction permeated. No experiments have been conducted with the porous ceramic membrane or the plastic membranes and vapor-vapor mixtures. The separation using the porous ceramic membrane would seem, however, to be similar to that obtained with the porous glass membrane, and the separation for the plastic membrane will be similar to that obtained with plastic membranes and gas-vapor mixtures.

EFFECT OF MOLECULAR WEIGHT

As in the case of gas-vapor mixtures, the effort of molecular weight for mixtures containing only vapors cannot be approximated because of the complexities introduced by adsorption phenomena with porous membranes and absorption or solution effects with plastic membranes.

PREDICTION OF SEPARATION

The equations which have been presented to date for porous membranes cannot be applied to the flow nor to the separation of vapors. The lack of correlation for vapors is attributed to a combination of distillation within the capillaries and adsorbed flow. It is recommended that vapor separation through porous media be determined experimentally for every mixture considered.

Separation results for vapors with plastic membranes appear to be identical to the values calculated from the permeability data and the rates of flow correspond to those predicted by Equation (3).

Conclusions

This paper presents an integrated picture of the current state of development of membrane separation in the gaseous phase. Although no work has been reported so far on thin metallic films, it is obvious that such films represent potentially useful membranes, particularly where high temperatures are applied and where ease of construction and shaping of a membrane may become important.

The effect of temperature and pressure on the separation of gas-gas mixtures by use of porous glass membranes and of gas-gas, gas-vapor, and vapor-vapor mixtures in the case of the plastic membranes can be predicted from permeability data with considerable accuracy. The effect of temperature and pressure cannot be predicted, however, for the separation of gas-vapor and vapor-vapor mixtures by means of either the porous glass or the porous ceramic membranes.

The effect of the molecular weight of gaseous substances on separation could not be determined for either the plastic or the porous membranes when vapors were considered. If any relationship exists between these factors, it is obscured by the complexity of the mechanism of flow.

The agreement between actual and calculated separation data for the plastic membranes is quite satisfactory for all three gas mixtures. For the use of porous membranes such agreement is entirely lacking for both the gas-vapor and the vapor-vapor mixtures although good agreement is found for the gas-gas mixtures. For the use of porous glass membranes separation of mixtures containing vapors occurs in the opposite direction to that predicted by the permeability data.

Good agreement was observed between predicted and actual downstream flow rates for both porous membranes with a gas-gas mixture and for all three mixtures with plastic membranes. A correlation was not observed between actual and predicted flow rates through the porous membranes when the mixtures contained vapors.

Since there appears to be no ready means of comparing the relative separation efficiencies of the various membranes, the final choice of a membrane for a specific separation must be based upon a comparison of actual experimental data obtained under actual operating conditions. Furthermore, the final decision concerning the choice of a membrane is very complex, and such a decision cannot be made on the basis of the separation data alone, but must include, and will often be determined by, consideration of economic factors.

At the present state of development membrane separation in the gaseous phase constitutes a promising field. Actual applications, however, are still limited to special applications, as, for example, isotope separation. A more complete knowledge of membrane separation potentialities will lead to applications which at present are accomplished more economically by conventional separation methods. Also, by the development of membranes which possess greater separation efficiencies and permit higher rates of flow the field of application of this method of separation will be greatly enlarged. The development of better membranes with a greater selectivity and a greater permeability would, of course, make the use of such membranes for separation more economical.

Acknowledgment

We wish to express our grateful appreciation to the United States Atomic Energy Commission for sponsorship of the many investigations which form the basis of this treatise.

Notation

b = proportionality constant
$b' = b/T$
c = proportionality constant
$c' = c/\sqrt{T}$
F = fraction permeated (N_p/N_f)
G = rate of flow (g-moles/min.)
K = permeability constant ($P\sqrt{T}$)
M = molecular weight
N = rate of flow (std. cc.-cm./sec.-cm.^{2})
P = permeability constant (std. cc.-cm./sec.-cm.^{2}-cm. Hg)
p = downstream pressure (cm. Hg)
p' = average pressure $(\pi + p)/2$
T = temperature (degrees Kelvin)
X = composition (mole fraction)
α = ratio of the permeability constants (P_A/P_B or K_A/K_B)
η_M = viscosity (centipoises) for gas mixtures
π = upstream pressure (cm. Hg)

Subscripts f, o, p, refer to the feed gas, high pressure outlet gas, and low pressure outlet gas streams, respectively.

Subscripts and superscripts T, A, B, refer to the total flow rate, components A, B, respectively.

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entrainment from bubble cap trays

D. J. Simkin, C. P. Strand, and R. B. Olney

Shell Development Company, Emeryville, California

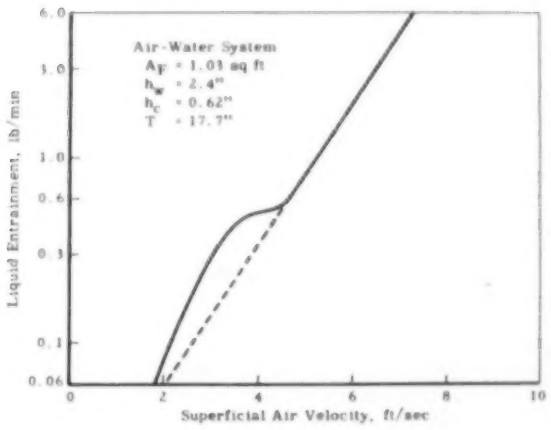


Fig. 1. Representative entrainment curve for bubble cap trays.

Entrainment data from an investigation of small bubble cap trays of 14.75 in. diam. have been correlated in terms of vapor and liquid densities, surface tension, tray spacing, column cross section, vapor velocity, weir height, and calculated crest. The data are correlated with an average deviation of ±10%. A comparison of this correlation with pertinent data in the literature shows reasonably good agreement, average deviations for different sets of data falling in the range of 10 to 30%.

A comparison of correlation entrainment values for bubble cap trays with experimental entrainment values for a typical Turbogrid tray design is also presented.

In the design of bubble cap columns for optimum capacity and efficiency it is at times necessary to consider the amount of liquid entrained in the vapor stream rising from the tray and the effect of this entrainment on capacity and efficiency. Furthermore, estimation of the entrainment is important in determining the contamination of overhead and side-cut streams. At the present time no generally acceptable method for predicting entrainment from bubble cap trays is available in the literature. The capacity indices presented by Souders and Brown (*10*), Carey (*1*), and Kirschbaum (*6*) indicate points of significant entrainment and are consequently important in determining tray capacity, but they do not yield quantitative estimates of the entrainment at either capacity or below-capacity flow conditions.

Eduljee (*2*) gives an equation relating entrainment (defined as the weight ratio of entrained liquid to dry vapor) to the vapor density, bubble cap tray spacing, slot opening, and static seal. This equation correlates the logarithm of the entrainment defined thus as a linear function of the parameter (slot opening/slot length)$^{3.42}$. Because of the extreme sensitivity of the predicted entrainment to the slot opening by this equation and uncertainty in the prediction by available methods of slot opening, this correlation is of doubtful validity when applied to many bubble cap tray designs. The uncertainty is enhanced by the fact that the slot opening on an operating tray with a number of caps does not ordinarily correspond to that for a single cap with no cross flow of liquid. There is a need, therefore, for a reliable method for estimating entrainment even if the method is somewhat restricted in application.

The correlation of entrainment from bubble cap trays presented in this paper is based on unpublished entrainment measurements. Comparison of the correlation with literature data on bubble cap entrainment indicates that there is reasonable agreement between predicted results from the correlation and the experimental data for the range of tray loading and tray structural variables most representative of commercial bubble cap columns. In addition to the correlation for entrainment from bubble cap trays, comparisons between entrainment from Turbogrid trays and bubble cap trays are shown.

Experimental Basis for Bubble Cap Entrainment Correlation

The entrainment data on which the correlation is based were obtained in a 14¾-in. diam. column. The trays used in the experimental tests had two bubble caps and the structural variables investigated included tray spacing, weir height, and cap design. Both liquid and vapor flows were varied in the investigation and the systems air-water and air-spindle oil were tested. The air-spindle oil system had an interfacial tension of 30 dynes/cm. To obtain the data the entrainment was collected and measured on a collector tray above the top operating bubble cap tray. The collector tray had no downcomer but had, otherwise, the same geometry as the other trays in the column. This method of measuring entrainment may not be truly representative of tray-to-tray entrainment within a bubble cap column section but in view of the fact that results achieved by this method are more reproducible (*11*), it was selected.

Table 1 summarizes the structural details of the bubble caps and trays and the flow rates

represented in the tests and used in developing the correlation. In addition to the layouts described, several others were studied in which cap design alone was a variable. The correlation is limited however to the layouts described in Table 1 as being most representative of bubble cap trays encountered commercially. The criteria used were the riser and slot area per tray.

Development of the Correlation

The tray riser and slot areas for the correlation were limited to the range ordinarily encountered in acceptable bubble cap tray designs. Therefore, experimental data for tray designs with low riser or slot areas are not correlated by the equations developed; moreover, the correlation does not apply well to tray spacings of less than 12 in. It has been shown (5) that for low tray spacings in perforated trays with downcomers, it is necessary to use $(T + n)$ as a correlating parameter for tray spacing where n is a constant.

Besides the limitation on tray structural variables covered, the correlation was restricted to the vapor velocity range in which entrainment becomes significant and in which most commercial bubble cap tray applications fall. This flow rate limitation is illustrated in Figure 1, which shows a typical entrainment curve for the air-water system. For superficial air velocities of less than 4 ft./sec., the liquid entrainment is apparently a complex phenomenon, and inasmuch as for air velocities of less than 4 ft./sec. the corresponding vapor load parameter is low compared with those encountered in industrial practice, no attempt was made to correlate the data in this range of vapor flow velocities. In any event, entrainment rates are low in the excluded flow rate range. For air velocities greater than 4 ft./sec., log En is a linear function of the velocity, and since this relationship was found to hold over the selected range of structural variables, it was adopted as the fundamental basis for the correlation. It should be noted that in contrast to previous attempts at correlating bubble cap tray entrainment, En is taken here to be the weight rate of entrainment rather than the ratio of entrainment to vapor flow. Use of entrainment in this manner appears essential to the success of the correlation.

The vapor loading parameter adopted was $U_a(\rho_g/\Delta\rho)^{1/2}$. Although the use of this function was not investigated in experimental tests in which the vapor density was varied, it is indicated by analogy to the established capacity indices. The effect of tray spacing is coupled with the vapor loading parameter by an additive term, c/T, where c is a correlation constant. The effects of cap slot height, slot opening, static seal, and weir crest were found to be correlated by including these factors in the logarithmic term together with the entrainment. The resultant equation for entrainment for the air-water system with an interfacial tens of 70 dynes/cm. is

$$\text{Log}_{10}\left(\frac{En}{A_f(h_w + h_c - h_s + h_s)}\right) = -3.95 + \frac{27.3}{T} + 10.75\,U_a\left(\frac{\rho_g}{\Delta\rho}\right)^{1/2} \quad (1)$$

The corresponding equation for the air-spindle oil system (30 dynes/cm.) is

$$\text{Log}_{10}\left(\frac{En}{A_f(h_w + h_c - h_s + h_{s_o})}\right) = -3.725 + \frac{27.3}{T} + 10.75\,U_a\left(\frac{\rho_g}{\Delta\rho}\right)^{1/2} \quad (2)$$

Table 1.—Entrainment from Bubble Cap Trays

Bubble cap, tray, and column details, rate and physical variables tested. Correlation basis and literature data

	Correlation basis			Sherwood and Jenny	Holbrook and Baker	Strang
Type of Cap	Round pressed	Round cast	Round cast	Round	Round cast	Hexagonal (across flats)
Cap detail:						
Nominal O.D., in.	5.5	5.7	5.7	4.0	2.75	4.25
Height, in.	4.25	4.13	3.94	3.00	3.125	4.00
Cap. I.D. at top of slots, in.	5.31	5.06	5.10	.....	2.375	.....
Minimum riser I.D., in.	3.07	3.07	3.07	2.00	1.625	3.00
Riser area, sq.in./cap	7.40	7.40	7.40	3.14	1.50*	7.03
Inside cap area, sq.in./cap	22.2	20.2	20.4	12.6 *	4.46*	15.9 *
Annular area, sq.in./cap	12.5	8.90	9.95	9.56*	2.96*	8.87*
Reversal area, sq.in./cap	9.65	10.5	9.08	8.15*	1.28*	2.36*
Type of slots	closed rectangle	open trapezoid	open trapezoid	open trapezoid	open trapezoid	open trapezoid
Slots per cap	36	28	33	33	14	24
Slot area, sq.in.	0.22	0.259	0.293	0.117	0.296	0.42
Slot width at base, in.	0.236	0.354	0.354	0.1875	0.309	0.375
Slot width at top, in.	0.236	0.079	0.197	0.125	0.219	0.1875
Slot height, in.	0.985	1.42	1.10	0.75	1.125	1.50
Skirt clearance, in.	0.394	0.197	0.55	0.25	0.00	0.25
Slot top elevation, in.	1.65	1.617	1.65	1.00	1.125	1.75
System tested	air-water air-spindle oil	air-water air-spindle oil	air-water air-spindle oil	air-water	steam-brine	air-water
Column diam., in.	14.76	14.76	14.76	18.0	8.0	36.0
Weir length, in.	11.5	11.5	11.5			
Weir height, in.	1.97–2.99	1.97–2.99	1.97–2.99			
Caps per tray	2	2	2	7	2	27
Cap center to center spacing, in.	7.48	7.48	7.48	5.25	3.63	5.5
Liquid rate, gal./min.	16.7–41.9	16.7–41.9	16.7–41.9			
Static liquid height, in.				1.77	1.73–3.03†	2.31
Liquid density, lb./cu.ft.	52.4–62.3	52.4–62.3	52.4–62.3	62.3	59.8	62.3
Vapor density, lb./cu.ft.	0.0735	0.0735	0.0735	0.0735	0.0369	0.0735
Liquid viscosity, centipoises	1–16	1–16	1–16	1		1
Interfacial tension, dynes/cm.	73–30	73–30	73–30	73	59–64	73

* Approximate, insufficient data.
† Observed dynamic height.

In Equations (1) and (2), h_s is the slot opening calculated by the Rogers-Thiele (7) slot opening equations with coefficients modified to fit the data of Griswold (3), and U_o is the vapor velocity based on the free column area, A_f, defined as the total column cross section minus one downcomer area.

The weir crest, h_c, can be calculated from the familiar Francis weir formula,

$$h_c, \text{ in.} = \left(\frac{q}{2.98\ l_{cw}}\right)^{2/3} \tag{3}$$

or from other weir crest equations where required. The slot opening equation for trapezoidal slots was

$$\frac{Q}{A_s} = 0.70\left(\frac{\Delta\rho}{\rho_g}\right)^{1/2}\left[\left(\frac{W_2 - W_1}{W_2 + W_1}\right)\frac{h_s^{5/2}}{h_o^{2}} + \left(\frac{2.5\ W_1}{W_2 + W_1}\right)\frac{h_s^{3/2}}{h_o}\right] \tag{4}$$

The similar equation for rectangular slots was

$$\frac{Q}{A_s} = 0.88\left(\frac{\Delta\rho}{\rho_g}\right)^{1/2}\frac{h_o^{3/2}}{h_o} \tag{5}$$

Equation (1) agrees with 75 entrainment measurements with an average deviation of 11%; Equation (2) correlates air-spindle oil data for 14 runs with an average deviation of 10%.

Comparison of Correlation Equations with Data in the Literature

Data in the literature reporting entrainment measurements falling within the range of experimental variables having significant interest are relatively scarce. When the correlation equations were compared with the experimental measurements, all data obtained in columns of the order of 2 in. diam. were excluded as nonrepresentative because of wall effects. In addition, the data for layouts with too low riser or slot areas were not considered. The data not thus eliminated are those of Sherwood and Jenny (9) and of Strang (11) for the air-water system and those of Holbrook and Baker (4) for steam-brine. Figure 2 shows the comparison between the correlation and the data of Sherwood and Jenny and those of Strang. The agreement is good, average deviations being 10 and 20% respectively for the two sets of data. Comparison with the data of Holbrook and Baker, shown in Figure 3, indicates an average deviation of 30%. These data, however, show a low order of reproducibility, and so a considerable deviation relative to any correlation is to be expected. Included in Table 1 are descriptions of the bubble cap layouts, compared in Figures 2 and 3 to the correlation equations.

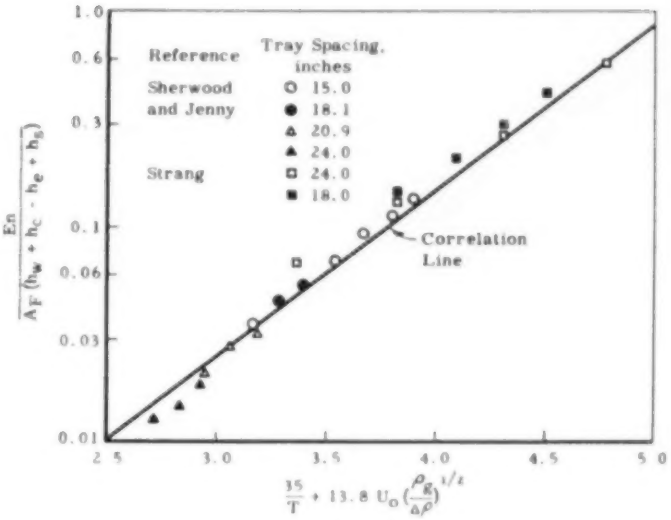


Fig. 2. Comparison of correlation with data of Sherwood and Jenny, and Strang.

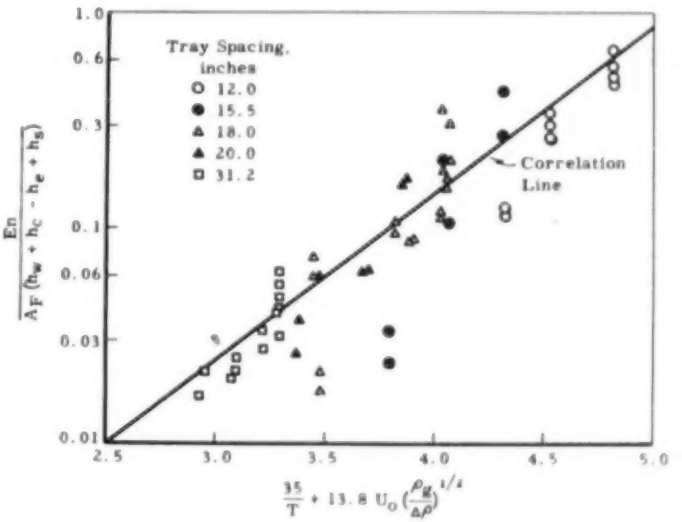


Fig. 3. Comparison of correlation with data of Holbrook and Baker.

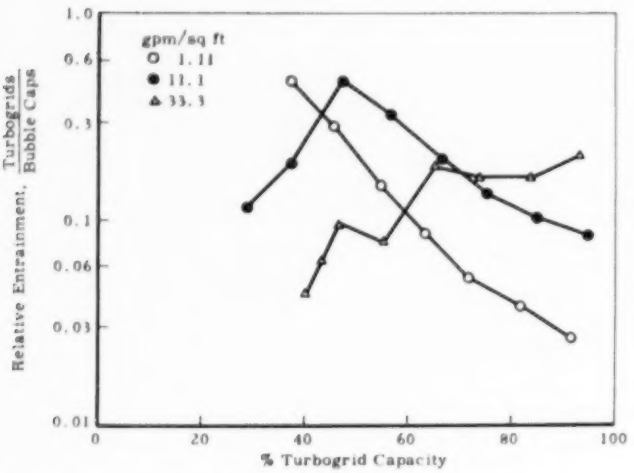


Fig. 4. Relative entrainment from bubble cap trays and Turbogrid trays without downcomers (high capacity Turbogrid trays).

Limitations of the Correlation

Although the correlation of the experimental data appears to be acceptable, some uncertainty may limit the applicability of the correlation equations. Of the variables covered, tray spacing and liquid submergence appear to be adequately correlated; it should be noted noted however that several of the sets of data in the literature (see Table 1) were obtained with no liquid flow and consequently do not include the effect of a weir crest. In the work of Holbrook and Baker (*4*) dynamic liquid levels and slot openings were visually observed, and these rather than calculated values were used in comparing the data to the correlation. The semilogarithmic relation between En and vapor velocity is well established but the use of the generalized vapor loading parameter $U_a(\rho_g/\Delta\rho)^{\frac{1}{4}}$ is not. The effects of interfacial tension have not been adequately explored as is shown by the difference between Equations (1) and (2). The experimental data used in developing the correlation included the effect of liquid flow across the tray but the column diameter was too small to establish any of the effects cross flow of liquid would have on entrainment. The literature data do not provide any clarification of this point since cross flow of liquid was not employed in a column with a diameter large enough to test this variable. Cross flow of liquid probably is a significant factor in large columns, however, and this consequently renders the correlation somewhat uncertain. Other factors which are believed to affect the entrainment include liquid viscosity and number of cap rows per liquid pass. As limited by the correlation basis described previously, cap design and spacing are probably not significant variables provided riser and slot area specifications are met.

Entrainment from Turbogrid Trays

Entrainment measurements for Turbogrid trays have been obtained for a wide range of liquid and vapor flow rates and of tray structural variables. The column used in these experimental tests had a cross-sectional area of 9 sq.ft. and the tray spacing used was 18 in. The data were obtained with the air-water system and the entrainment was measured by collecting the entrainment in a collector tray above the top operating Turbogrid tray. The collector tray spacing above the top tray was equal to the tray spacing in the Turbogrid section of the column. The air stream from the collector tray passed through a York mat to deentrain residual entrained liquid in the exit air stream.

Comparative entrainment rates for bubble cap trays and representative Turbogrid trays are illustrated in Figure 4 for high capacity Turbogrid trays (*8*). The bubble cap entrainment rates were calculated by use of Equation (1). The bubble cap tray design selected for comparison with the Turbogrid data had the same total tray area as the Turbogrid tray (9 sq.ft.), with 2½-in. weir height and 18-in. tray spacing, and a layout with 10 round cast caps. The layout had a riser area of 8.7% of the tray area and a slot area of 8.9%. The downcomer area was 13.5% of the total column cross section and the weir length was 2.1 ft. The relative entrainment rates are plotted as a function of the fraction of Turbogrid capacity for three liquid rate conditions corresponding to low, average, and high liquid loadings.

The comparison in Figure 4 shows that Turbogrid trays have considerably lower entrainment than a bubble cap tray of normal design at the same tray spacing. The entrainment ranges from 3 to 60% of the calculated bubble cap rate. A considerable effect of liquid flow is noted and the relative entrainment rate declines as capacity is approached for low and average liquid rates and increases at high liquid rates. The higher entrainment rate from the bubble cap tray results in part from the greater liquid holdup on the bubble cap tray as reflected in the magnitude of the term $(h_o + h_w - h_e + h_s)$ in Equation (1). An additional factor in the higher bubble cap entrainment is the higher value of U_a for the bubble cap tray case resulting from the obstruction of a part of the column cross section by the liquid downcomer.

Notation

A_f = column cross section available for vapor flow, sq.ft.
A_s = single slot area, sq.ft.
c = constant
En = entrainment, lb./min.
h_c = weir crest, in.
h_e = elevation of top of slots, in.
h_o = slot height, in.
h_s = slot opening, in.
h_w = weir height, in.
l_{ew} = effective weir length, in.
n = constant
q = liquid flow, gal./min.
Q = vapor flow, cu.ft./sec./slot
T = tray spacing, in.
U_a = superficial vapor velocity based on area A_f, ft./sec.
W_t = width of slot opening at top of slot, in.
W_x = width of slot opening at base of slot, in.
ρ_g = gas density, lb./cu.ft.
$\Delta\rho$ = liquid density—gas density, lb./cu.ft.

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programming of kinetic calculations for automatic computation



Fig. 1. Massachusetts Institute of Technology Whirlwind Computer—Central Control and Input-Output Equipment.

J. A. Beutler

E. I. du Pont de Nemours & Co., Inc.
Wilmington, Delaware

The chemical engineer is not generally familiar with problems of numerical analysis, the details of programming strategy, or the coding methods for machine solution. A recent problem in predicting the behavior of a chemical-reactor system, requiring the solution of a group of complex mathematical equations, was posed in a paper by Messrs. Gee, Linton, Maier and Raines (C.E.P., October, 1954, page 497). The kinetic equations used were described in the aforementiond paper. In the present example these problems were answered by trial or by literature searches. Because of the potentially wide application of machine methods to solve chemical engineering problems some experience gained in solving this problem is recorded here so that others with similar problems may arrive at useful answers more directly.

Once the technical problem has been stated in mathematical terms, as was done in the companion paper (*4*), a practical means must be found of arriving at the desired solutions. The objective is to find the particular values of the operating parameters which will maximize production of the reactor system when it is subject to temperature restrictions and fouling tendencies. Mathematically the problem is to find the maximum value of the production S, where

$$S = \int_o^{\phi} x_o(\phi, t_1, t_2, t_3)d\phi.$$

x_o is determined by solution of the following equations which were developed in the companion paper (*4*):

$$\frac{\partial z}{\partial L} = k_1\left[\frac{(1-z)}{x_o}\frac{(r-z)}{(r+1-z)^2}\right]\left[\frac{pD_j}{t+273}\right]^2 exp\left(A_1 - \frac{B_1}{t+273}\right) \quad (1)$$

$$\frac{\partial t}{\partial L} = \frac{x_o\Delta H}{wc_p}\frac{\partial z}{\partial L} - U\pi D_j(t_j - t) \quad (2)$$

$j = 1, 2, 3$, designating the jacketed sections

$U = 0$ for adiabatic section
$U = 10$ for $(t_j - t) > o$

$$\frac{\partial p}{\partial L} = k_2\frac{x_o^2(r+1-z)^2(t+273)^2}{p} \quad (3)$$

$$\frac{\partial U}{\partial \phi} = -k_3x_o^n(1-z)^nU^2exp\left[A_2 - \frac{B_2}{t+273}\right] \quad (4)$$

where k_1, k_2, k_3, A_1, A_2, B_1, and B_2 are numerical constants.

Matching the Problem and the Computer

Experience has shown that, in general, a variety of computers can be used in solving reactor problems. Various characteristics of different computers can be used to advantage only if the choice is made with a specific problem in mind. It is important to note that other reactor problems have been successfully solved on machines rejected for the present problem. The widely available electronic analog computers were among these considered.

ANALOG COMPUTERS

The specific difficulties in adapting the present problem to solution on an electronic analog computer include the following:

1. **Equation (1) is extremely nonlinear. At least three variable multipliers and two arbitrary function generators are required. The cascading of this number of nonlinearities in an analog machine usually causes difficulty in maintaining accuracy since variable multiplication and function generators are inherently less accurate than linear operations for an analog computer.**
2. **The irregular behavior of the heat-transfer term in Equation (2) is awkward for analog computation. As described previously $U = 0$, $U = 10$ or U is based on previous calculations (Equation (4), depending on computed temperatures or length. The jacket temperatures and the diameter, D, vary from one section to the other. The change of conditions along the reactor could be solved on analog machines by considering the equation separately for each set of conditions; however, this method would quadruple the already large number of solutions.**

The difficulties briefly enumerated apply largely to electronic differential analyzers. The electromechanical differential analyzer, such as the large unit at Massachusetts Institute of Technology, can handle these equations without serious difficulty since it is possible to stop the integration at approximate points

and make changes in parameters and boundary conditions. However, this possibility again slows down the solution, and with its already slow operating speed the mechanical differential analyzer would not appear to be the best means of solution.

The disadvantages led to the conclusion that available analog computers would not adequately solve the present problem in a reasonably short time. If simplifications could have been made in the equations or the total number of solutions required could have been reduced, the advantages of analog solution might have reversed this conclusion. Neither compromise was desirable in the present problem.

Digital Computers

Some of the punch card equipment furnish examples of digital machines. The I.B.M. 604 or 605 and the Remington-Rand 409 electronic calculating machines find many uses in technical computation but are not considered general-purpose computers. These machines operate at rather high speeds but have insufficient storage capacity for problems of the type considered here. The I.B.M. Card-Programmed Calculator is at present the most widely used digital computer. The larger and more versatile digital computers, the "electronic brains," include such machines as the Eniac, Ordvac, Seac, Univac, Whirlwind, I.B.M.'s 701 (Defense Calculator), and a number of others.

Digital machines have several advantages.

1. **There is no theoretical limit on machine accuracy. Most digital machines operate on numbers from 4 to 10 decimal digits. Moreover, programming techniques allow use of multiple length numbers if additional accuracy is required.**
2. **Digital computers can be programmed to make a large number of choices or branchings dependent on computed quantities.**

Some limitations of digital computer for solving kinetic problems are listed below.

1. **The time per solution is frequently longer for digital machines.**
2. **Problems of numerical analysis are introduced. Since digital machines cannot handle continuous data directly, finite difference approximations are necessary for solution of differential equations. The mathematical theory of approximation methods is rather lacking even though much interest has been created by the availability of digital machines.**
3. **Machines were not widely available at the time this problem arose. The machines themselves are expensive, the larger machines representing investments of from 250,000 to more than one million dollars.**

COMPARISON OF DIGITAL COMPUTERS

The differences between digital computers are primarily of size and flexibility rather than of principle of operation. Two digital computers, the Card-Programmed Electronic Calculator of I.B.M. and the Whirlwind of Massachusetts Institute of Technology, are considered here. These two machines are representative of the extremes in speed, cost, and size of present-day computers.

Descriptions of the C.P.C. and typical applications of it are available in the literature (*10, 7*). The basic limitation of this computer is the speed with which program cards can be read. Maximum card reading speed is 150 cards/min., a time considerably below the actual arithmetic speed available. For some problems the relatively small storage capacity (200 to 900 decimal digits) is a definite handicap. A less obvious but quite important limitation is that the program is stored externally on cards and the cards are read strictly in sequence. The larger machines store the program internally, thereby reducing the time for reading instructions and also permitting random access to all instructions. In order to incorporate branching* of any large degree of complexity with the C.P.C., one must resort to a large number of distinct card decks, the sequence of which is determined by manual intervention. These procedures are not attractive when a long program with many branches is to be run. These factors result in rather slow solution of problems such as described here. C.P.C. time required to solve the present problem was estimated at from 750 to 1000 hr. or 30 to 40 twenty-four-hour days. At the time this problem was undertaken it was not possible to obtain this large amount of C.P.C. time. Because of these various factors, further consideration of the C.P.C. was dropped.

M.I.T. Whirlwind Studied

A survey of other digital computers then available indicated that it would be desirable to use a computer with the capabilities of the M.I.T. Whirlwind (*3*). It is well to point out that the availability of large digital computers is much better at the time of this writing than it was a year or two ago. The following remarks on the Whirlwind apply, except for some details, to such computers as the I.B.M.-701, Univac, and the Engineering Research Associates 1101 computer, which are all presently available for application to commercial problems.

Whirlwind I, developed under the sponsorship of the Navy and Air Force by M.I.T., is among the fastest general-purpose digital computers built to date. More than 20,000 operations/sec. are carried out in the all-electronic arithmetic and control sections. Rapid access memory is provided by electrostatic storage tubes which have a capacity of 1,024* *words* or locations (each of 16 binary places) for program orders and numerical data. Internal operation is entirely in binary form and a parallel mode of operation is employed. Input to the computer is primarily by means of punched paper tape read by a photoelectric reader capable of reading 200-1,000 words/min. Several forms of output equipment can be used. These include punched paper tape, electric typewriter (Flexowriter), and a cathode-ray oscilloscope which can present point-by-point graphs of data or tables of numbers; either form can be recorded then photographically under control of the computer.

The computer occupies approximately 2,500 sq.ft. and contains some 5,000 vacuum tubes and 11,000 crystal diodes. Figure 1 shows a view of the control and input-output section of the computer which is designed to carry out the basic arithmetic operations of addition, subtraction, multiplication and division, as well as several data-transfer operations. Means are also provided for modifying stored orders so that the computer can be programmed to *rewrite* its own programs. Conditional and skip-program orders are provided so that the normal sequential operation can be modified whenever desired. Additional orders are available to control magnetic drum and tape equipment and the input-output equipment. The less frequently used arithmetic operations such as square root, sine, and cosine evaluation are not built in but can easily be incorporated as short pretested programs known as subroutines. These subroutines as well as those used for converting decimal input information to binary form, those for floating-decimal arithmetic, and many other commonly used programs are inserted manually. It is planned to place these subroutines on magnetic tape for convenient incorporation into any desired program.

DIGITAL COMPUTER SOLUTION OF DIFFERENTIAL EQUATIONS

The first step toward a final solution, and perhaps the most important one, is the choice of a finite difference method. Second a mathematical flow diagram is made to indicate the over-all strategy of the program. Third a coded program is written in a form required by the particular machine to be used. Fourth the program is checked for errors; this is known as "debugging" a program. Finally the program is run to obtain useful results.

The equations describing reactor operation are written as partial differential equations with reactor length and onstream time as the independent variables. Essentially concentration, temperature, and pressure solutions along the length of the reactor at rather coarse intervals of on-stream time are required.

* **In a branching procedure the computer tests a number for its algebraic sign: if it is positive, the machine does *A*; if negative, the machine does *B*.**

* **The above data describes Whirlwind as of June, 1952, when the present problem was solved. Recently 2048 words of magnetic core storage have replaced the electrostatic storage. Two magnetic drum units and five magnetic tape units are now in operation.**

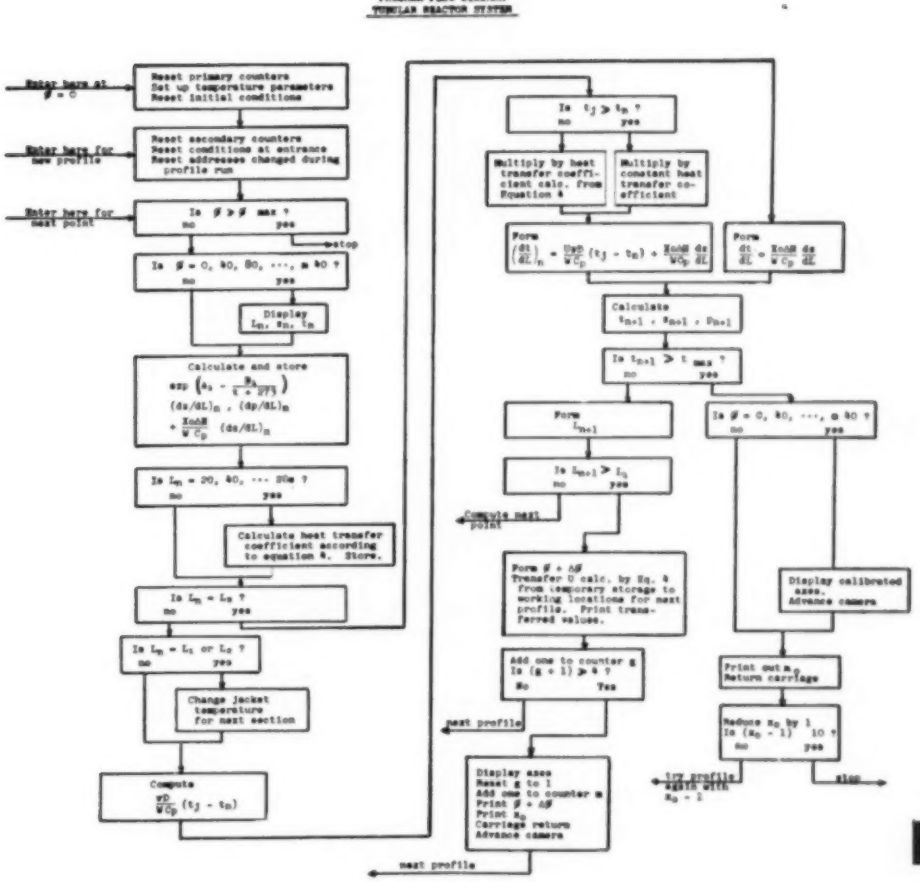


Fig. 2. Digital Computer Program Flow Diagram for Tubular Reactor Performance Equations.

If the heat-transfer fouling equation (Equation (4)) is replaced by a simple finite-difference expression, one has only the solution of three simultaneous *ordinary* differential equations to be concerned with. The problem then becomes that of choosing from among the numerous numerical methods one that will provide results of adequate accuracy with a minimum expenditure of machine time and facilities. It should be emphasized that if one wishes to obtain, say, 5% over-all accuracy in the numerical solution of a nonlinear equation, it is necessary to use a numerical method having considerably higher accuracy since small errors early in the solution tend to be amplified and at a later point may become serious. It is desirable that the numerical method used add nothing of its own to the solution. It is also important to choose a method for which an estimate of the error can be made without lengthy auxiliary calculations.

In order to recognize the relative merits of various methods and to point out the pitfalls of several well-known methods, the nature and behavior of these approximating procedures are discussed in the Appendix.

After a satisfactory numerical method has been chosen, the next step is to translate the problem into machine language. In order to organize the solution, it is strongly recommended that a flow diagram be drawn up similar to flow sheets used to indicate the forward flow and recycling steps in chemical process work. The flow diagram should indicate clearly the major steps in the solution of the problem, particularly those steps which involve branching operations, i.e., alternate paths. Closed loops or cycles, involving a large number of steps or alternate entrance and exit points, should be clearly indicated. A well thought-out flow diagram will speed up programming and will aid in avoiding errors if later changes in the program are required. The flow diagram should be complete enough to show the general plan of computation. It is usually worth while to indicate the criterion for all branching operations. The flow diagram (Figure 2) indicates the strategy used to solve the present problem.

The next step is coding, i.e., filling in the details of the flow diagram. Ultimately each operation carried out by the computer must be specified, just as one would write out every step required for a desk computer operator.

These orders might be speeded up by the use of shorthand notation or code. This is usually done in coding problems for large computers. For example, the simple addition program would be written for Whirlwind as follows:

Register	Instruction	
1.	ca 200	*clear* accumulator and add in contents of register 200
2.	ad 201	without clearing *add* contents of 201 to accumulator (a + b)
3.	ad 202	without clearing *add* contents of 202 to accumulator (a+b+c)
4.	ts 203	without clearing, *transfer* contents of accumulator to register 203
	Data	
200.	a	
201.	b	
202.	c	
203.	Contains sum (a+b+c) after instruction No. 4 is executed.	

The parallel between the instructions for the desk-computer operator and for Whirlwind should be noted. For further details and examples of coding, the report "Programming for Whirlwind I" (*9*) should be consulted.

Since Whirlwind performs as many as 70,000,000 orders an hour, each of which must be specified in advance, it is necessary to adopt procedures which will permit reuse of parts of a program. In the program for the present problem fewer than a thousand orders were specified in order to direct the machine for an hour. By setting up counting procedures it is possible to write out a sequence which can be repeated a specified number of times. Once the desired number of repetitions has been accomplished, the computer automatically proceeds to the next phase of the calculation. The sequence of orders may operate on any desired data so that rather complicated iteration cycles may be written easily.

The extensive use of subroutines can also simplify the task of coding a large problem. Essentially, subroutines provide a means whereby frequently used programs may be coded efficiently once and for all, and then used in solution of portions of subsequent problems.

In adapting a problem for solution on a digital machine, one is faced with the task of fixing the position of the decimal point so that no operation carried out by the computer results in a number exceeding the capacity of the machine. Most machines are operated so that all numbers will be less than unity in absolute value; that is, the decimal (or binary) point is assumed to be at the extreme left of each storage or arithmetic register. In this case no product of numbers can be greater than 0.99999 . . .. However, one could still add two numbers, for example, .7 and .7 to obtain 0.4, where the carry digit has been lost as overflow. If the machine used numbers with 6 decimal places, scaling could be arranged such that computing is done with .000007 and .000007, the sum being .000014. One could remember that the number in the computer would be 10^{-6} times its true value. In most problems the scaling process is quite tedious since it is not possible to use one scale factor throughout. A convenient way out of this problem is to let the computer determine and keep track of its own scale factors by so-called floating-point subroutines in which a number is expressed in the form $a \cdot 10^{p}$. This is similar to scientific notation where $0.1 \leq a < 1$. For example, −60720 would appear as −0.6072/5 and +0.0006072 as +0.6072/−3. In the case of Whirlwind a number of floating-point subroutines are available with various numbers of significant digits in both parts of the number.

Although floating-point systems reduce programming time many fold, their use generally leads to more computer operations to perform a given arithmetic operation, and hence slows down the effective speed of the computer. In practice one must then balance programming costs against machine costs in order to determine whether or not a floating-point system should be used. When very long, highly repetitive programs are anticipated one tends not to use floating-point systems. In the present problem a floating-point system was used because of the wide ranges of numbers encountered. Since it was not easy to predict number sizes in advance, scaling would have been quite difficult. The relatively short word length of Whirlwind (4 to 5 decimal digits) strongly influenced this choice.

After the program is completely coded and subroutines specified, the program is, in the case of the Whirlwind, punched on paper tape with a Flexowriter electric typewriter, a step usually performed by trained clerical help. The program is then ready to be placed in the computer for operation.

The first attempt at running a new program usually ends quite soon. Even the most carefully planned program needs to be "debugged" before it is ready for useful computation. The fact that it is not practical to tie up a large computer while a programmer searches for his errors, makes it necessary to obtain key information quickly and take the problem off the machine while the errors are located. To assist the programmer, postmortem programs have been formulated which are inserted in the computer after trouble has been encountered. The postmortem program is designed to obtain diagnostic information with which the programmer can locate the error. Error location is the most time-consuming part of programming and demands much ingenuity on the part of the programmer.

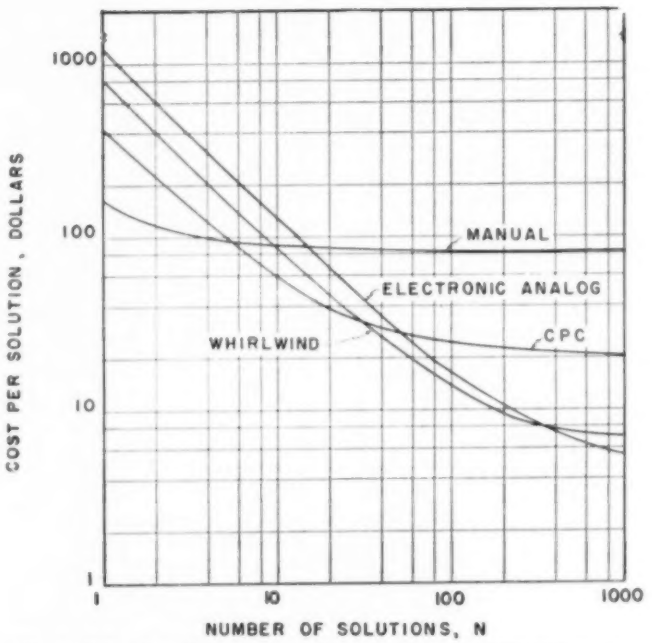


Fig. 3. Unit cost for tubular reactor equations solved on various computers.

In the present problem, results of the computation were in the form of oscilloscope plots of temperature and concentration vs. length of the reactor. The plots are point data derived from the computed digital values. A point-by-point calibration axis is also displayed under control of the computer. The heat-transfer coefficients computed by Equation (4) as well as values of x_s were typed out by means of the Flexowriter. Use of the oscilloscope plots was dictated by the fact that complete typewritten results would have approximately doubled the required computing time since the printing facilities (being mechanical) are so much slower than the computer proper.

Economic Considerations

In considering machine solution of problems, a comparison is generally made of the cost of solution on various machines and the cost by manual methods. A convenient basis for comparison is the cost per solution as given by

$$C = \frac{a \cdot A}{n} + b \cdot B$$

where

C = cost per solution, dollars
a = hours of programming, coding and debugging time
b = machine hours per solution
A = programming cost, dollars per hour
B = machine cost, dollars per hour
n = total number of solutions required.

The first term in this formula represents the preliminary costs charged against each solution. The important

factor in many cases where n is relatively small is the size of a since it basically determines the lower limit on problems that can be solved economically. In addition, a has a strong influence on the value of n at which the cost curves cross for various computers.

For a digital computer, as a first approximation,

$$a = \frac{100}{E}\left[w + \left(1 + \frac{B}{A}\right)d\right]$$

where

E = programmer efficiency, 100% for professional programmers, perhaps 20% for a novice
w = programming and coding time, hours
d = debugging time, hours
A,B, as before

One factor frequently underestimated is the debugging time d. For large computers B/A is approximaetly 30 and hence a can easily grow at an alarming rate. w and d are functions, primarily, of problem complexity and programming methods and depend to a lesser extent on the type and refinement of the computer. No universal index of complexity is available to compare various types of problems, so that statements as to the magnitude of a will be limited here to the present reactor problem. For other types of problems widely different estimates are obtained. As already suggested, the use of floating-point systems can reduce the size of w and d by a factor of from 5 to 25.

Unit cost data for the present problem are given in Figure 3. In this plot it has been assumed the $A = \$10$, that $B = \$5$, 25, 40, or 300 for manual, electronic analog, C.P.C., or Whirlwind computation respectively. The latter figure is the author's estimate based on similar large computers. It is used since there is no published cost figure available for Whirlwind. Values of b are on the basis of 100 intervals in the numerical solution. The estimated electronic analog curve is shown for the purpose of rough comparison only since in the present problem such computers had already been eliminated for other reasons. The anticipated economic advantages of using a large digital computer when large numbers of solutions are required, compared with small machines or manual calculation, are clearly demonstrated. In the region between 10 and 100 solutions the large and small computers are probably equivalent, to judge from this and similar plots for other problems. The desk computer becomes impractical if more than 10 to 20 solutions are required. It is unfortunate that the electronic analog must be ruled out on other grounds since it would seem to have definite economic advantages when a large number of solutions are required. Experience on this and other problems indicates that a problem requiring a total of a week's time, that is, $b \cdot n$ of the cost equation, by manual methods will likely be solved economically on a digital computer. Recent trends in improved programming methods indicate that this lower limit can be considerably reduced.

Acknowledgment

The author gratefully acknowledges the assistance he received from the staff of Project Whirlwind at Massachusetts Institute of Technology.

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Appendix

ERRORS IN FINITE DIFFERENCE APPROXIMATIONS

The finite-difference methods with which this paper is concerned operate in the following manner. The initial value of a function and its derivatives are given. By substituting the finite difference approximation in the differential equation one is able to extrapolate to the values of the desired function or solution. If a small extrapolation interval is used, one is able to extrapolate with considerable accuracy. After a few steps, advantage can be taken of what already has been computed to improve further extrapolation. There are many finite difference methods; some of the better known are identified with the names of Euler, Milne and Runge-Kutta.

Errors in finite-difference approximations are round-off errors, truncation errors, and accumulated errors.

Round-off errors are introduced whenever a limited number of digits are used to represent quantities. Their effect, in most cases, can be reduced to satisfactory levels when solving differential equations by carrying more digits in the calculations than are required in the answer.

Truncation errors are those introduced by the approximate nature of the finite-difference methods. Truncation errors are essentially the local errors committed each time the numerical formula is applied. These are a direct function of the interval size, the particular numerical method, and the particular equations being solved.

process design

Accumulated error is the total error after a number of extrapolation steps have been carried out. Accumulated error takes into account how a truncation or round-off error is propagated through the solution. The accumulated error is the most important error consideration since it represents the total error which has built up during the solution. In the rest of the discussion concern will be had only with accumulated error.

Accumulated errors may (1) build up continuously in one direction, (2) oscillate with decreasing amplitude or proceed

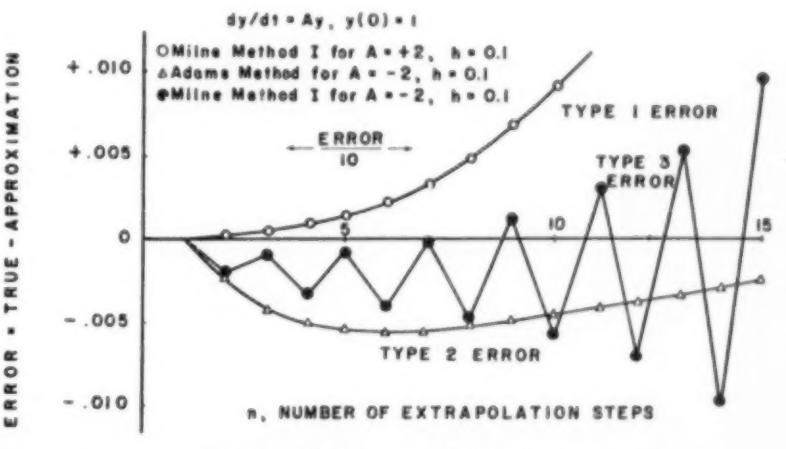


Fig. 4. Behavior of accumulated errors.

smoothly (stable methods), and (3) oscillate around the true solution with increasing amplitude (unstable methods). These three ways in which the error may behave are illustrated in Figure 4.

A continuous error build-up in one direction occurs when the equation being solved leads to a nonequilibrium type of solution. For example, in the differential equation $dy/dt = Ay$ for A positive, the solution $y = ce^{At}$ increases exponentially as t increases and does not reach an equilibrium. Problems having nonequilibrium solutions require particular care when finite difference methods are employed. Extremely small intervals are needed as well as accurate formulas. Fortunately, most physical problems do reach an equilibrium solution as in the present problems; therefore, this case will not be considered further.

The second type of error represents the desired behavior. The error can be decreased by the use of either smaller intervals or a method with a smaller truncation error.

The third type of error is most undesirable since it rapidly takes over and masks the true solution. By the time $n = 25$ in the example of Figure 4 the solution will have "blown up." Whether there are errors of Type 2 or Type 3 depends not on the equations being solved but on the particular approximation method used. Unfortunately many well-known methods* exhibit an error behavior of the third type. It can be shown (*8*) that this situation will prevail in certain methods *no matter how small* the extrapolation interval h is taken. As n becomes large, the oscillation will predominate. Clearly it is desirable to avoid these methods in machine computation whenever a large number of extrapolation steps are involved. It can also be shown that the Milne predictor-corrector method (*6*), the central-difference extrapolation processes (*8*), and the Nystrom methods (*8*) exhibit errors of the third type.

A stability analysis for other numerical methods can be carried out, and it is found that Euler's method†, Adams method‡, and the Runge-Kutta methods are inherently stable and exhibit errors of the second type. The error analysis for this problem also demonstrated the possibility of inherently stable methods used to solve nonlinear equations being stable for part of the solution and unstable at other times. Caution must also be exercised in using certain of the Adams-type methods in which a large number of previous values are used to reduce the truncation errors. As pointed out by Rutishauser (*8*), these methods may also be unstable.

These remarks, though incomplete, point out the necessity of making a thorough analysis of the errors involved in any numerical method before its use in machine computation. Examples of error analysis are given by Collatz (*2*), Milne (*6*) and Rutishauser (*8*).

In the exploratory work on the present problem unstable oscillations were observed when using the Milne predicator-corrector method. When Euler's method was used no oscillations were observed. On the basis of truncation error alone Milne's method should be vastly superior whereas, in fact, after a number of extrapolation steps Euler's method was more accurate. These considerations lead, in the present problem, to the use of Euler's method with entirely satisfactory results as long as the interval was kept rather small.

Because the detailed error analysis for systems of nonlinear equations becomes quite complicated, it is expedient to have a more direct method of estimating the accuracy of computed results. A procedure that is frequently useful is (1) to use a method that is stable for linear equations, i.e., inherently stable, (*2*) to make a check on the size of accumulated errors by halving or doubling the extrapolation interval and comparing this solution with the previous one. Agreement of the two solutions to the desired accuracy indicates that the larger interval (or perhaps a still larger interval) can be used. The extra labor required in duplicating the solution is a small price to pay for a check on the accumulated errors.

Presented at A.I.Ch.E. Washington, D. C., meeting.

* Milne's Method 1 is

$$y_{n+2} = y_n + 2h\,y'_{n+1}$$

where

$h = \Delta t$, the extrapolation interval of the independent variable

$y_n = y(nh)$, the value of $y(t)$ at $t = nh = n\Delta t$

$$y' = \frac{dy}{dt}$$

† $y_{n+2} = y_{n+1} + h\,y_n'$

‡ $$y_{n+2} = y_{n+1} + \frac{h}{2}\,(3y_{n+1}' - y_n')$$

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market research as a tool of management

R. E. Chaddock

Hercules Powder Company,
Wilmington, Delaware

In the last decade a quiet revolution has been taking place in chemical market research activities. Chemical market research is relatively new although market research or marketing research goes back many years. In the past a consumer type of market research was used by large merchandising firms in an attempt to determine the buying habits and the likes and dislikes of the public. Overemphasis on the survey technique, as represented by door-to-door interviews and lengthy questionnaires, was evident. Utilizing the information obtained in this manner, the market analyst arrived at certain conclusions in consumer preferences. This market research tool is still effectively used, but, in the chemical industry today, market research men have a more integrated approach to the selling and research problems.

Prior to World War II chemical market research men with closely confined jobs were usually gatherers of numerous statistics. Results of their efforts were capitalized on mainly by the sales departments. This slowly changed over the years and, in addition to sales, a well-organized and well-operated market research division became of value to research, operating, purchasing, engineering, and other departments of a large company. Today chemical market research is being recognized as a potential tool of top management. It should be emphasized, however, that market research is just another of the many tools and specialized skills that enable executives to do their jobs better by providing facts upon which to base decisions. *Market research is an advisory function which helps to reduce errors of judgment and to eliminate some of the risks which are inherent in operating a business.*

The location of the market research group within a chemical company has also changed over the last decade. Market research functions were originally located within the department or under the executive who recognized the need for such an activity. Even today a poll of the chemical industry would show that market research is being conducted under sales directors, in research departments, under top management, and in some cases in purchasing departments.

It is rather widely recognized that market research should be a staff function supervised by top management preferably reporting to a vice-president having an interest in both sales and research. This removes the market research group from the day-to-day activities of the company and enables it to devote time to longer range projects requiring a broad over-all view. In

addition, the market research group probably has a better chance to be more objective and critical in its work when located directly under top management than as a subdivision of an operating or auxiliary department.

This evolution in the activities, organization, and techniques of market research in the chemical industry has finally placed chemical market research in the position of being an effective tool of management. Other activities which the market group has performed in the past have not been abandoned but instead have been supplemented by additional duties and responsibilities.

Assisting Management

In the highly technical chemical industry it is most important that a company maintain its objectivity, look facts in the face, and take action accordingly. One of the important functions of a market research group in assisting management is to analyze its own company and constantly review from several viewpoints its objectives, performance, growth rate, and future interests.

SALES VIEWPOINT

A sales analysis of present products should be made periodically in order to keep management informed of the position of its products in the industries served. This analysis should consist not only of past history but also should include an estimate for at least five years together with estimates of total industry growth. Many such analyses are made now by sales departments based on information received by them from their field men. This is a good type of analysis for the day-to-day selling job which must be done but is not satisfactory for keeping top management completely informed. By and large, salesmen are and should be of an optimistic nature. However, they can be the most pessimistic persons in the world if they happen to have a few days of bad luck.

The information which salesmen send to headquarters about the sales potential in their district is oftentimes colored by immediate local business conditions and not basic enough to be of real, long-range value. New competitive products should be carefully studied in making a sales analysis in order that allowances can be made for their impact on the future growth of existing products. Recognition must be taken of trends in the industry which is being served.

RESEARCH VIEWPOINT

The importance of good research has long been recognized by top management as indicated by its willingness to allocate large sums of money to maintain and equip research laboratories. Research activities should be organized on as efficient a basis as possible since even under the best conditions only a few research projects develop into a commercially profitable product. Personnel and management in research should take advantage of all opportunities to obtain facts before initiating research programs and evaluating research results.

One method used by chemical market research groups to help in this work is to study constantly and to survey thoroughly the needs of industry. It is relatively easy to obtain information on various industries and their problems, but it is oftentimes difficult to separate the practical from the theoretical problems. A market research man should be able to tell his company what problems are worthy of research efforts and what their effective solution could mean in terms of markets.

An analysis of a company's research objectives from a market standpoint should be periodically made in order to insure that the research program will be a commercial as well as a technical success. A chemist with an idea for a new process to make an existing product or a new product for an existing industry can use market studies to sharpen up his creative thinking. A properly conducted market survey may show him that his idea is unsound or such an investigation may encourage him to proceed with his work. Market studies can be used to guide research thinking but should not be used to restrict or hamper the flow of new ideas.

A negative conclusion from a market survey is never the final answer for through perseverance, hard selling, and advertising, there is always the possibility that new markets can be created or old markets enlarged.

NEW CAPITAL INVESTMENTS

The final follow-up of market studies envisages the justification of a capital investment in manufacturing facilities for a new product. Although the market research group has followed the research program quite closely, this type of market study is difficult and probably less accurate than others but is of primary importance to top management in investing a company's funds. Market studies of this nature are another tool for management to use in evaluating the business risks which surround the introduction of new products.

When plans for new construction projects or for expansion of existing plants are presented for management approval, they should be accompanied by a careful market analysis. A market research group, working outside of an operating department, can possibly be more objective in analyzing future markets than any other group. This does not mean that such personnel will be more accurate, but they will have a detached viewpoint and will not be under pressure to have their findings justify a predetermined answer. These studies are of a basic nature and take into account the various factors that come into play in dealing with markets. Factors, such as present competitive products, new competitive research products, trends within the industry being served, present and future selling prices, are among the subjects for study in any survey.

Informing Management

Another important function of a market research group in assisting management is to keep it informed, by means of objective surveys, of major industrial activity in the United States, and more particularly, of activity in the chemical industry. Management must be familiar and up-to-date not only on the past, present, and potential future of its own company but also should be in the "know" on the plans and thoughts of competitive companies in the chemical industry and to some extent of all industries served by the chemical industry. This function involves preparation of periodic reports, probably on an annual basis, dealing with the growth rates of the major industries, the growth of various segments of the chemical industry, and a discussion of various trends taking place within the different divisions of the chemical industry.

GENERAL BUSINESS CONDITIONS

It is important that management be informed of the general business condition of most major industries since many of these industries are either present or potential customers. Information of this nature is significant when management is considering long-range sales forecasts, as such information may indicate that the company's products are being sold to a slowly dying industry; conversely, it may indicate that the company is serving an industry enjoying a healthy, vigorous growth.

ANALYSIS OF GROWTH OF END CHEMICAL GROUPS

The analysis of the growth of end chemical groups within the chemical industry keeps management specifically conversant with what is happening to various chemicals. This particular analy-

sis should include not only the past performance of the end chemical group, but, in addition, an effort should be made to project the growth for at least a five- or ten-year period. Such data serve management well, especially when it has under advisement possible diversification by investment in one of these segments of the chemical industry. It is better always to time one's entrance into a new field at an early period so that one can ride along during its initial, healthy growth. In addition, management is informed well in advance when declines are taking place in order that it may plan accordingly. Rather broad categories are used in this analysis, such as plastics and resins, synthetic fibers, commercial fertilizers, and rubber processing chemicals. A further break-down of the specific products within these groups can and should be made for keeping management up to date. It often happens that although the end chemical group may show a slow growth rate there may well be a particular chemical within the group which is growing at a rapid rate at the expense of other products.

TRENDS—IMPORTANT FACTORS

Trends within a given industry disclose much valuable knowledge and should be recognized early in order that action can be taken by management to protect present sales outlets and take advantage of new ones. Market trends are always taking place such as the recent rapid growth of water-based paints, which have made it easy for the average householder to do his own painting. This in turn has been reflected by changes in paint ingredients, has resulted in the use and sale of new products to this industry and the decrease in sale of older products. Another market trend has been to unit-packaged and prepackaged items in grocery and department stores which in turn accounts for the excellent growth of cellophane and polyethylene packaging materials. The sale of automatic washers for clothes and dishes has brought about the rapid growth in synthetic detergents and the chemicals used in manufacturing these compounds. Many other examples of trends which are favorable to one industry and disastrous to others could be given.

Management should know about these trends so that remedial action can be taken if the market for an existing product is threatened or to take advantage of new opportunities which may develop.

Analysis of Companies as Purchase Prospects

Market research has a place as a tool of management in analyzing companies which may be desirable purchases. In this case market research would analyze the company from a business standpoint to determine its sales position in the industry which it serves, the competitive position of its products, its sales methods, and new products which have been introduced. In addition to analyzing an outside company from the standpoint of its existing business, the growth potential of that particular industry should be studied. The ideal acquisition, of course, is one having a synergistic effect whereby, when the two companies are put together, the final sum is greater than the addition of the parts.

marketing

Place of the chemical engineer

Chemical market research has opened up a new field for graduates in chemical engineering. It has been said many times by many people that the education received by a chemical engineer prepares him for a career in all phases of industrial management. As a matter of fact, such training is useful in many other fields. Men with chemical engineering backgrounds have had successful careers in medicine, law, and even the ministry. It is quite evident, therefore, that the training a chemical engineer receives today gives him a way of thinking and a method for attacking problems rather than a specific means of carrying out a job.

Since chemical market research is a new function, little formalized training in this subject has been given and most present market research men have been self-taught. The training received by a chemical engineer in organizing his work, taking a problem apart, solving the various segments, and putting the parts together again give him a unique background for this job. Equally important as the formal education of the market research personnel is their aptitude for the work. Since considerable traveling, contacts with people, and the acquisition of a wide industrial background are involved, it is probably safe to say that the personnel engaged in market research should be a bit on the extrovert side. However, like the other fields in which chemical engineering personnel are engaged, the one factor overshadowing all the rest is that market research men grow in their jobs and acquire knowledge and experience as time goes on.

R. E. Chaddock

chemical engineering aspects of titanium metal production

R. L. Powell

Titanium Metal Corp. of America, New York

Production of titanium metal is one of the newer and more rapidly growing industries of the country. In February, 1946, R. S. Dean, J. R. Long, F. S. Wartman, and E. L. Anderson of the Bureau of Mines described a 15-lb. batch-size titanium production unit before the Chicago meeting of A.I.M.E. (*1*). Three years later in the Minerals Yearbook (*2*), the Bureau of Mines refers to a 100-lb./day titanium pilot plant with a second slightly larger one going into production by the end of the year, in addition to the Bureau's own enlarged facilities. It has been reported that titanium sponge production was 50 tons in 1950; 500 in 1951; 1,075 in 1952; and 2,241 in 1953 (*3*).

In this paper titanium metal production is discussed from the ore to sponge titanium. Since the steps involved are essentially chemical ones, production on a commercial scale has depended largely on the application of chemical engineering techniques and principles.

Raw Materials

Titanium is one of the more common elements in the earth's crust, ranking ninth in the list. Table 1 gives representative chemical compositions of three titanium-bearing ores and a slag made from Canadian ilmenite. Ilmenite is the most plentiful of these ores and is widely used in the titanium dioxide pigment industry. Rutile is less plentiful but has a much higher titanium dioxide content. The presence of appreciable iron content in a chlorinator feed requires the extra steps of separating the iron chloride formed and recovering the chlorine values. High content of elements forming nonvolatile chlorides, such as magnesium and calcium, introduces additional problems in a chlorinator. Though all of these materials could be used in the manufacture of titanium metal, rutile will be considered here.

Chlorination

The existing commercial processes for making titanium metal depend upon the use of titanium tetrachloride. This may be made from rutile ore by high-temperature reaction with chlorine in the presence of a reducing agent, usually carbon. The net reactions involved are

	AUSTRALIAN	ILMENITE		Q.I.T.
	RUTILE	INDIAN	Mc INTYRE	SLAG
TiO_2	96.2	59.1	44.9	77.2
TOTAL Fe	0.8	26.4	33.9	9.6
SiO_2	0.6	0.7	3.8	5.5
Al_2O_3	0.9	1.3	2.1	8.7
$CaOMgO$	1.4	1.0	4.0	5.4

Table 1. Ore analysis.

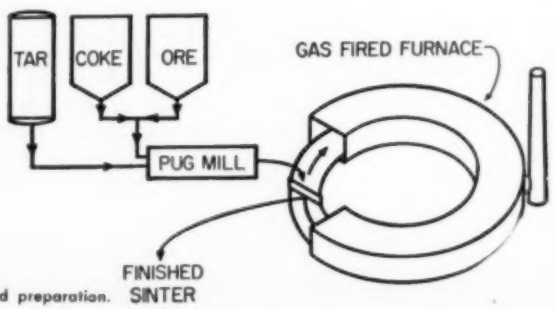


Fig. 1. Feed preparation.

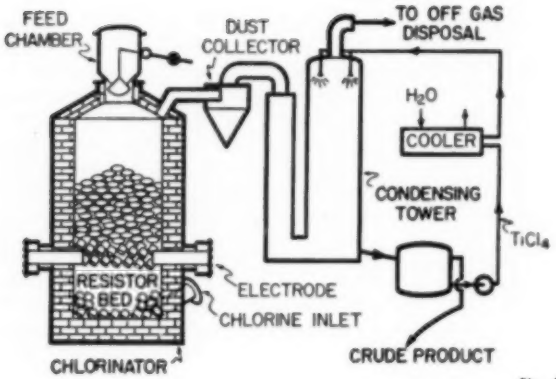


Fig. 2. Chlorination.

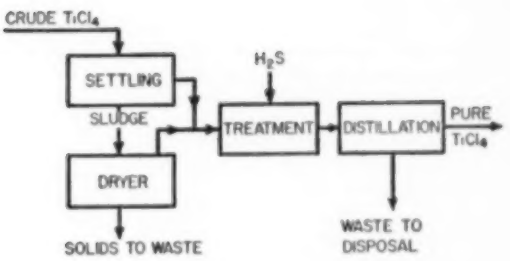


Fig. 3. Purification.

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

$$TiO_2 + 2Cl_2 + 2C \rightarrow TiCl_4 + 2CO$$

These reactions are exothermic, the first producing 101,000 B.t.u./lb.-mole at 800° C. and the second producing 19,800 B.t.u./lb.-mole at 800° C., and in practice are carried out at temperatures ranging from 700° C. to 1,000° C.

Two types of equipment can be used for the chlorination of rutile—fluidized-bed chlorinators and static chlorinators for briquetted or sintered material.

In preparation of briquettes or sinter for static bed chlorination, it is necessary that the carbon be well mixed with the titanium ore. One process for the preparation of materials for chlorination, described by McTaggart (*4*), consists of baking a mixture of rutile, coal, and coal tar. Figure 1 shows a flow sheet of chlorination feed preparation by this process.

Here coke is shown substituted for the coal used by McTaggart. The process consists of feeding measured amounts of coke, ore, and coal tar into a steam-heated pug mill. The mixture is dumped onto the moving table of a circular kiln. A spreader (not shown here) spreads the mix to form a uniform layer. The table carries the mix into the heated zone of the kiln. Air is admitted into the first zone of the kiln to burn the volatile material given off by the tar. Air in the subsequent zones is limited to prevent over-oxidation of the carbon in the mix. Heat is supplied by burners both above and below the table with zone control. The last section of the kiln is unheated to serve as a cooling zone. The finished sinter is plowed off the table by a diagonal blade, broken up and transferred to intermediate storage.

Chlorination is carried out in brick-lined steel vessels. Sufficient brick thickness is required to allow the shell to be operated below the temperature where a chlorine attack is serious. Even the most carefully installed brick lining will allow some chlorine leakage to the shell. The type of equipment used for the chlorination of sintered or briquetted material is illustrated in Figure 2. Extra heat is required to bring the reactor to temperature and balance the heat losses during operation. One method of doing this consists of filling the bottom of the chlorinator with a carbon black resistor bed. Electrodes around the chlorinator and connected to a variable voltage power source contact this bed. The chlorine is added at the bottom of the resistor bed and preheated before it contacts the charge.

As operation proceeds, a static bed chlorinator accumulates nonreactive material. This requires that the unit be taken off the line at intervals and cleaned.

Several advantages can be obtained by operating fluidized chlorinators. The sintering or briquetting step is eliminated as ground coke and rutile are fed directly to the bed. Overflow allows the continuous removal of nonreactive material without shutdown. Preheating a fluidized unit is achieved by burning coke. During a start-up period, dried flue gas and air mixed to give the desired heat rate are used to keep the bed fluid. Coke feed is continued during this period to prevent depletion of the carbon content of the bed.

Since most of the metallic impurities in rutile are fully as easy to chlorinate as titanium is, the product gases contain iron chloride, vanadium oxychloride, silicon tetrachloride and several other metal chlorides; in addition, they contain unreacted rutile and carbon dust, unreacted chlorine, phosgene, carbon dioxide, and carbon monoxide. A dust collector in the chlorinator off-gas line will reduce the amount of solids in the product titanium tetrachloride. From the dust collector the gas stream goes to a cooling-condensing system, where the titanium tetrachloride is recovered. Use of spray towers with circulating, cooled titanium tetrachloride has been found to be a satisfactory condensing system. The circulating titanium tetrachloride washes out any solid material and prevents accumulations that tend to hinder direct use of a heat exchanger. The product titanium tetrachloride overflows continuously from the circulating tank and is transferred to crude storage.

Purification (See Figure 3)

As most metal chlorides are insoluble in titanium tetrachloride, they exist in the crude product as suspended solids just as any dusts from the chlorinator that may have escaped the dust collector do. Dissolved in the crude titanium tetrachloride are silicon tetrachloride, tin tetrachloride, vanadium oxychloride, small amounts of phosgene, and other gases. The first step is to remove the solids. This may be achieved by settling. One impurity requiring special attention is vanadium oxychloride as it boils at 127° C. compared to 136° C. for titanium tetrachloride. It would be possible to design a distillation column to make this separation, but it has been found more advantageous to precipitate the vanadium chemically. Many agents have been found that will render vanadium oxychloride insoluble in titanium tetrachloride, the ones most used being hydrogen sulfide and finely divided copper. For large-scale operation, the use of hydrogen sulfide has been found to be most satisfactory.

The class of purity required of titanium tetrachloride is very high; an example is the maximum desired total oxygen content of 50 p.p.m. It is difficult to write a set of specifications that will assure that the tetrachloride will produce good metal. The metallic impurities in the tetrachloride can be readily determined but they are not so important in the final quality of the metal as is the amount of carbon, oxygen, and other

nonmetallic impurities. The best test for the tetarachloride is the grade of metal it will produce.

In the design of a purification unit for titanium tetrachloride, care must be taken to prevent its contacting water in any form. The reaction with water forms HCl and an oxychloride of titanium. If this reaction should occur in the atmosphere, a cloud of dense fumes results, which is very irritating. If it occurs inside equipment, the oxychloride is a notorious plugger-upper. If any moisture contacts the product after final distillation, the oxychloride will be carried into reduction as a contaminant. In the use of water or steam in heat exchange, extreme care must be taken to see that no leaks occur. Even the most minute leak will generate enough HCl to cause corrosion and also a rapid increase in the leak rate. Some installations use electric or direct-fired heat to avoid this problem. Another partial solution is to use heat exchangers of a double tube sheet design where any tube sheet leak will be to the atmosphere.

Reduction

At present the titanium industry is based on the magnesium reduction of titanium tetrachloride. This process was developed by William Kroll and is described in U.S. Patent No. 2,205,854 and by an article in Trans. Electrochemical Society (*5*). This process depends on the high-temperature chemical reaction:

$$TiCl_4(g) + 2Mg(1) \rightarrow Ti(s) + 2MgCl_2(1).$$

The titanium metal forms a spongelike mass in the reaction zone. To form 1 lb. of titanium metal, 3.96 lb. of titanium tetrachloride reacts with 1.015 lb. of magnesium and forms 3.975 lb. of magnesium chloride. If the reaction is carried out with a deficiency of magnesium, the following side reaction will occur—g = gas, s = solid, l = liquid

$$TiCl_4(g) + Mg(1) \rightarrow TiCl_2(1) + MgCl_2(1)$$

$$2TiCl_4(g) + Mg(1) \rightarrow 2TiCl_3(1) + MgCl_2(1)$$

$$TiCl_4(g) + Ti(s) \rightarrow 2TiCl_2(1)$$

$$3TiCl_4(g) + Ti(s) \rightarrow 4TiCl_3(1)$$

As these reactions decrease the over-all titanium yield, it is important that an excess of magnesium be present at all times. Part of the magnesium is trapped in the sponge, becoming unavailable for reaction. Depending on conditions magnesium utilization will vary between 60 and 90%.

Since titanium metal at the temperatures of the reduction reaction will combine irreversibly with oxygen and nitrogen, it is necessary to carry out the reduction in a sealed container under an inert gas atmosphere. The inability to remove oxygen from titanium metal is associated with the fact that the oxide is soluble in the metal.

The reduction reaction is carried out in steel vessels maintained between the melting point of $MgCl_2$(712° C.) and the temperature at which titanium picks up iron from the reactor walls, usually considered to be 1,000° C. The reaction releases a substantial amount of heat, usually in a localized portion of the vessel. This localized heat release makes heat removal somewhat difficult as adjacent areas of the vessel must be maintained at the 712° C. to prevent freezing of the magnesium chloride. The magnesium for the reaction can either be precharged to the vessel or charged in increments during the progress of the reaction. The by-product magnesium chloride is usually periodically drained from the reaction zone. The molten magnesium is lighter and floats on the magnesium chloride during the draining operation.

There are three variations available for carrying out the magnesium reduction process; reduction followed by leaching, reduction followed by vacuum distillation in a separate vessel, and reduction-distillation in the same vessel. The reduction step will be identical for the first two. Process steps for this type of reduction are shown. (See Figure 4.)

The reactor is a steel vessel with a flanged cover. The charge of magnesium, pickled free of oxides, is placed in the reactor and the lid bolted or welded on. This operation is carried out in a dry room to prevent any pickup of moisture by the residual magnesium chloride in the reactor. After evacuation and pressurizing with helium or argon, the unit is transferred to a gas-fired furnace. The unit is heated to reaction temperature, and the titanium tetrachloride feed is started. The feed can be either liquid or vapor. During the reaction magnesium chloride is periodically tapped from the vessel.

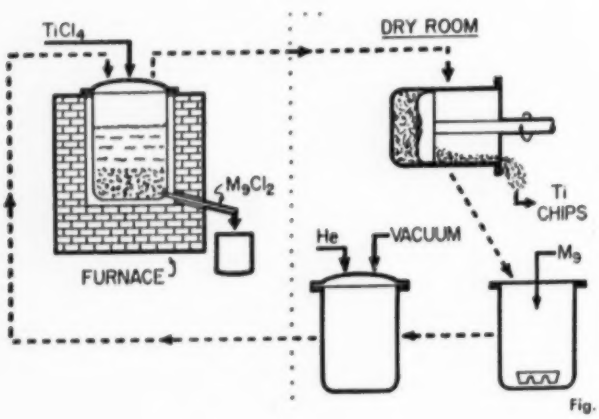


Fig. 4. Reduction.

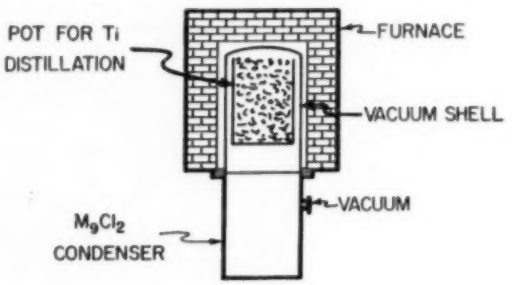


Fig. 5. Vacuum Distillation.

At the completion of the reaction the final tap is made and the vessel removed from the furnace for cooling. When the vessel and contents reach room temperature, the vessel is transferred to the dry room where the lid is removed and the contents bored out. This operation leaves a residual skin of titanium sponge and magnesium chloride. From the boring operation the chips of sponge titanium, containing some magnesium chloride and the excess magnesium, are transferred to the final step of separation from the magnesium and magnesium chloride.

Separation of Metal from Mg and $MgCl_2$

The final step in the preparation of sponge titanium metal is to separate it from the salts and other metal present. In the magnesium reduction this would be magnesium chloride and magnesium. Two basic processes are available for carrying out this separation; acid leaching and vacuum distillation. The publication by the Bureau of Mines in 1946 (*1*) described a process for leaching titanium metal in HCl. This product was satisfactorily consolidated by powder-metallurgy techniques. It was not, how-

ever, satisfactory for melting because of the fineness and gas content.

This led to the development of the vacuum-distillation process for this separation. This step is usually carried out at 900° to 1,000 °C. At 900° C. the vapor pressure of magnesium is about 90 mm. of Hg and magnesium chloride is about 7 mm. However, to insure good removal, pressures less than 100 μ (0.1 mm.) are preferred. Some practical aspects of maintaining a vacuum on such a system were described in a recent publication by Stoddard and Mooz (*6*).

Equipment for the vacuum distillation of titanium sponge is shown in Figure 5. The furnace can be electric or gas fired. Use of direct-fired furnaces requires that the shell withstand the collapsing force of a vacuum at 1,000° C. The Bureau of Mines has developed a vacuum-shell elecrtic furnace for carrying out distillations. By sealing the distillation vessel into the furnace and maintaining a rough vacuum on the shell, the main stress is transferred to the outside furnace shell that is insulated from the heating elements. The sponge titanium is contained in an inner pot or basket. A section of the vessel extending out of the furnace acts as the condenser for the volatilized materials. In this illustration the condensing section is below the furnace, but the reverse arrangement is also used.

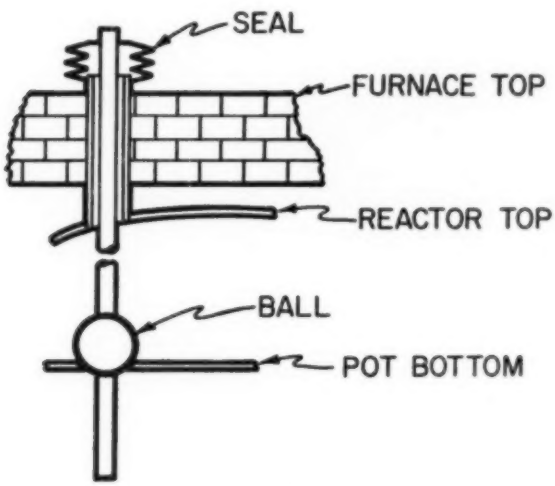


Fig. 6. Ball Valve.

One feature of distillation that requires considerable caution is the frequent occurrence of pyrophoric material in the condenser section. This material is believed to be a mixture of magnesium and lower chlorides of titanium. If a fire starts in the condenser section, care must be exercised to prevent its spreading to the titanium sponge. If a fire is once started in sponge titanium, it is very difficult to stop before the batch is spoiled. Only complete smothering with helium, argon, or some other inert material will stop a sponge titanium fire. Common fire-fighting materials such as water and carbon dioxide are completely ineffective.

As mentioned earlier, it is possible to carry out the reduction step in this same vessel. To do this, it is necessary to provide a feed pipe through the top of the furnace and some means of draining the magnesium chloride. This may be achieved by having a hole in the bottom of the inner pot plugged with a ball on the end of a rod as illustrated in Figure 6. The rod extends through a seal placed out of the heated zone. By using this modified system, a batch of metal can be prepared and distilled without exposure.

Recently leaching has been developed to the point where it gives sponge metal equivalent to distilled sponge. A comparison study of leached and vacuum-distilled products indicated that they were equal. Leached sponge having hardness numbers under 110 Brinell has been produced.

Other Processes

Many other methods for reducing titanium from its tetrachloride are under study. One of these is the use of sodium instead of magnesium. The electrolytic reduction of titanium tetrachloride is being investigated in a number of laboratories. Though successful aqueous or organic electrolysis has not been reported, high-quality metal can be made by fused-salt electrolysis.

One other process for making titanium metal carried out on a small scale is the iodide process. This process is used where the ultimate in purity of titanium metal is desired. The process depends upon the reversibility of the reaction between titanium metal and iodine to form titanium tetraiodide. At temperatures on the order of 1,200° C. or greater the iodide will decompose to form titanium metal.

This process has been carried out by using a starting titanium wire heated by electric current in an evacuated system. In the same container but somewhat removed from the wire is titanium metal of a lower grade. By the reversal of the reaction the metal is transferred from the sponge to the wire, and a heavy rod of titanium is built up. Rates of deposit and current available for heating the enlarged rod limit the size of a deposit that can be made by this process.

Decomposition of titanium halides in an arc or by reduction with hydrogen is discussed in the patent and other literature.

Titanium metal too impure for structurally usable titanium base alloys can be made by reducing titanium oxide. However, the titanium made by such processes has always been contaminated with carbides or oxides. One oxide process is the reduction of titanium oxide with calcium metal or hydride.

processes

This provides metal suitable for additions of titanium to other metal bases, but not for production of ductile titanium metal. Titanium for alloy in steel is made by reduction of a mixture of titanium and iron oxides to give a titanium iron alloy.

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Presented at A.I.Ch.E. Washington, D. C., meeting.

problems of communication

Arthur Secord

Brooklyn College, Brooklyn, N. Y.



One phase of human relations which often results in misunderstanding is in the transmittal of ideas expressed in words from one person to another. The words don't say what they were intended to say and the person addressed is as surprised as the speaker himself when the meaning finally has been clarified. Specifically when something goes wrong in your particular corner of the plant or office, the error or mishap usually is not ascribable to ignorance on the part of supervisors, but rather because somebody in a supervisory position said something to an individual who heard words which conveyed an entirely different meaning from what was intended. This is regarded as a breakdown in communication. That is what we are going to consider briefly in this article—how you can be a little more sure that when a man hears you speak he will hear what you think you said.

Five points covering the part speech plays in human relationships are analyzed here.

Point 1. Speak the other fellow's language.

Talking the other person's language is an important dictum, but few realize its practical applications and their significance. To illustrate: A plumber in the Middle West noticed that whenever a piece of metal pipe was plugged up and he put hydrochloric acid into it,



Fig. 1.

the pipe disappeared. Being an intelligent plumber, he stated his problem in writing to a prominent chemical research laboratory in a near-by city. The following answer was received: "The efficacy of hydrochloric acid is indisputable but the corrosive residue is incompatible with metallic permanance." Subsequently the technicians of that laboratory received another letter from the same plumber acknowledging his thanks for their approval of what he was doing, but he would still like to know what happened to the pipe. A more realistic chemist then wrote him to this effect: "In cleaning metal pipe, don't use hydrochloric acid as it eats the hell out of the pipe." Ah, the plumber got the idea! *You speak the other fellow's language—or communication does not take place.*

Another example from industry can be cited. During World War II, I had the honor of being called to a large plant in Detroit to take part in a conference called to solve certain problems. In this conference there were four ideas brought up for discussion:

(1) the problem itself,
(2) its origin and cause
(3) possible solutions
(4) the best solution

The problem in this case was a simple one—the speeding up of production of an essential war product in this particular plant in the city of Detroit. Management was almost universally agreed on the cause of the problem. It was the dumb, stupid women who were coming into the shop. One fellow said, "Let me tell you what I caught a woman doing last week. She was using a micrometer for a C-clamp and trying to tighten it up with a Stillson wrench." In contradistinction to that remark, a foreman stood up and said, "I had some pretty good luck with one of those women in job training. I took her over to the machine where she was to work and said to her, "You know that dial on the end of your food mixer—the farther you turn it to the right, the faster it goes." She said, "Yes." Then I said, "This works the same way." Everything on that machine I tried to compare with something in her home, and what do you know—she caught on right away.

Why shouldn't she? He was speaking her language. Many men, in their job training, talked to these women as though the women had been master machinists for twenty years. And when the women didn't understand they were "stupid." True, an element of stupidity was involved, but it was not on the part of the women. There is no doubt about it. You speak the other fellow's language or communication does not take place.

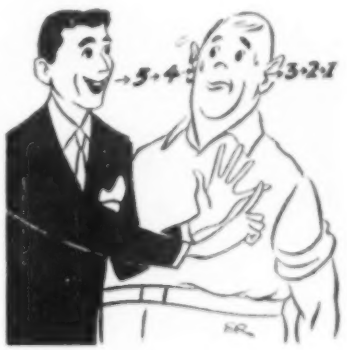


Fig. 2.

Point 2. In any speech situation never emphasize more than one item.

One plaint at a time is more effective than six or seven; likewise one commendation of a deserving performance makes more of an appeal than a string of praises. People in management often have the feeling that it is a waste of time to criticize anybody until considerable evidence has been piled up about the person in question. Suppose after much mental note-taking you have eight different criticisms of an employee. You may go to work one morning and you feel that you are thoroughly prepared with chapters and verses. So, you call the culprit down on 1-2-3-4-5, take a breath, and then give him 6-7-8. Then you go away. Do you know what has happened? The "guilty" person has only a general feeling that *something just went by!* What it was he doesn't know and the chances are he will forget all the points at issue—since there are so many—or he will remember either the first or the last item that you raised. Again it should be stressed that there is never room for more than one chief point in any one speech situation.



Fig. 3.

Point 3. Dramatize your example as a memory device.

Following naturally from point *2* is point *3*, which pertains to the dramatization of an example. On that point I can tell a true story.

One day I was going through a plant with a foreman and we came across the operator of a band saw that was protected by a hinged guard which was standing open. The foreman got the operator's attention and holding up a hand on which there were three stumps —once there had probably been fingers there—he said to the operator, "Ben, if I were you, I'd close that guard." That's an example.

That example did three things for the operator of that band saw: (1) it made clear to the operator what the foreman was talking about, (2) it made the foreman's request seem reasonable, and (3) *it made it impossible for the operator of that band saw ever to forget what he had been told.* These are the three purposes of an example: to make it clear, to make the request seem reasonable, and, by the use of some device, to help a man remember what he has been told.

At times of course an example is not readily available. Then one should wait until there is one. The operator or employee of whatever class won't remember what you tell him anyhow unless you have an example so why waste his time and yours.

One of the most difficult lessons for us on the management team to grasp, I sometimes suspect, is that we can learn from others no matter what particular job they hold. And I know of no better way to safeguard the flow of knowledge from the plant and office staff through the various levels of personnel until it finally reaches someone who can do something about it than this device of which I am writing. Don't correct a man until you have an example that will make clear why he had to be corrected—that will make your interruption of his thought processes seem reasonable, and, always have some device by which he can remember what you have told him. And that leads up to the next point.



Fig. 4.

Point 4. Master the use of praise.

Not long ago I spoke to a group in the Mt. Royal Hotel in Montreal. It was the annual dinner of the Quebec Association for the Prevention of Industrial Accidents. One of the features of the evening was the calling of two fellows up to the dais to present them with lapel buttons and certificates of membership in the Wise Owl Club. You know what that meant—some time during the past year each of those men had had the sight of one or both eyes saved because he was wearing eye protection, namely safety glasses. As those two men left the dais and returned to their table, I overheard a man at the speakers' table say to a neighbor, "That's the silliest thing I've ever heard of. *Why honor a man for doing what he should do?*" That statement has tremendous significance for you and for me. I wonder how that critic would like to live in a world where God operated on that basis. Do you realize what would be missing? Heaven! No reward for doing what you should do! Just Hell for those who didn't do what they should do! We are quick to criticize when things aren't going as they should, but we are very slow to give somebody a pat on the back when things are going properly. Give praise lavishly. It pays dividends.

Do you want to see a perfect example of industrial management in that special capacity? Go to the circus and watch the chap who runs the seal act. He is a perfect foreman with a pail of fish under one arm. Every time a seal does an act he gets a fish. I have watched the act, have studied it carefully, have even done research work on it—at some time during the act every seal gets at least one fish.

Absence of criticism does not constitute praise. An employee knows that you like his output only when you tell him so—a pat on the back, a smile, a word of encouragement, even a little upgrading. Let us take a look at it from another way. Here is a fellow doing an operation properly. At the next table or machine there is a man who is doing it wrong. So what does the average foreman do? He upbraids the first fellow. What happens? The second man gets lonesome. Talk with some psychologists who work in the field of problem children and they will tell you that there are boys and girls who will be noticed if they have to burn the schoolhouse down to get attention. And don't think for a minute that we ever change. You and I will be children so long as we live!



Fig. 5.

Point 5. Don't mix praise with censure.

Is there some technique whereby a man can praise his worker in one breath and then berate him in the next? Is it possible, in other words, to mix commendation with censure?

In the old days if you didn't like what a man did, you went to him, let him have it, then you walked away. That was known as the direct approach. Then a school of thought sprang up which said "That's bad. What you should do when you want to criticize a man is to go to the man and praise him to the skies. Tell him how wonderful he is. Get a smile on his face, then let him have it." Subsequently somebody came along with a refinement on that one. This reformer said, "That leaves a fellow with a bad taste in his mouth. The way to do it is to go to the man and praise him to the skies, then berate him, and finally praise him again." That was known as the sandwich method. Still another philosophy, a more direct one, won adherents. This was the never-praise-before-finding-fault idea. That same idea came to me from an industrial foreman. I was in Philadelphia in 1948 at a national convention of the National Association of Foremen. I was running a question-and-answer period on this topic and a foreman stood up and related the following incident: "I went up to a man and I said to him, 'Fred, you're the best turret-lathe operator we have in this shop.' Fred answered thus: 'I know that. What's wrong?'"

I lost a lot of sleep over that because I had been trained in the tradition which says, "if you must find fault always begin with praise and honest appreciation." Now let me get one thing straight. On this one point I think that idea is dangerous for industry, and for me personally. I believe that if such an idea is put into practice it would mean you permanently closed the door on ever being able to pay me a compliment because I would never "hear" the compliment. Any time you come and say one kind word to me, fear will enter my heart, and I'll say—"I know that—what's wrong?"

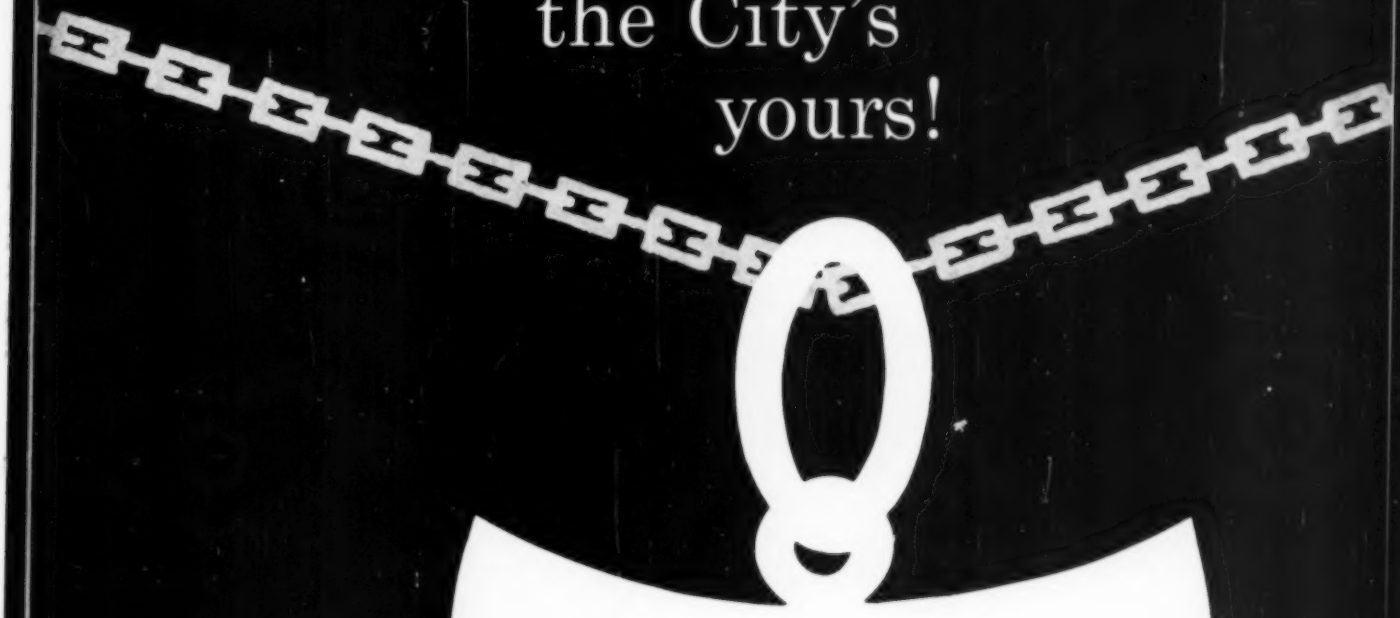
Suppose you do say, "this has got to be changed" and you tell me why, and of course give me an example. We talk it over, you drop around to my machine an hour, a week, or a month later, and say, "That last lot you turned out is the finest I have ever seen." I'll look you straight in the eye and say "Thank you," because I will know that you mean it.

I believe that every management man should keep the path open between himself and every one on his staff so that when a word of praise is given out, the recipient of it can truthfully say "thank you" instead of "I know that—what's wrong?" And I don't believe you can keep that path open unless when you come to criticize you begin directly with the criticism.

Briefly it has been said here that you and I, in our attempts to tell our personnel what we know, are passing on to the men who look to us for leadership and inspiration the knowledge which they must have if we are to have a mutual understanding. These remarks mean simply that my requests should be presented in terms of your needs, your hopes, your wants, your dreams, your aspirations. And if you want me to do something for you, you had better present that petition in terms of my needs, my hopes, my wants, my dreams, my aspirations. If this contact can be so established, our human relations will improve; knowledge will freely pass among us and our understanding will grow. Then the companies that we work for, and with, and each of us individually, will prosper.

Abstracted remarks from address given at Springfield, Mass., meeting.

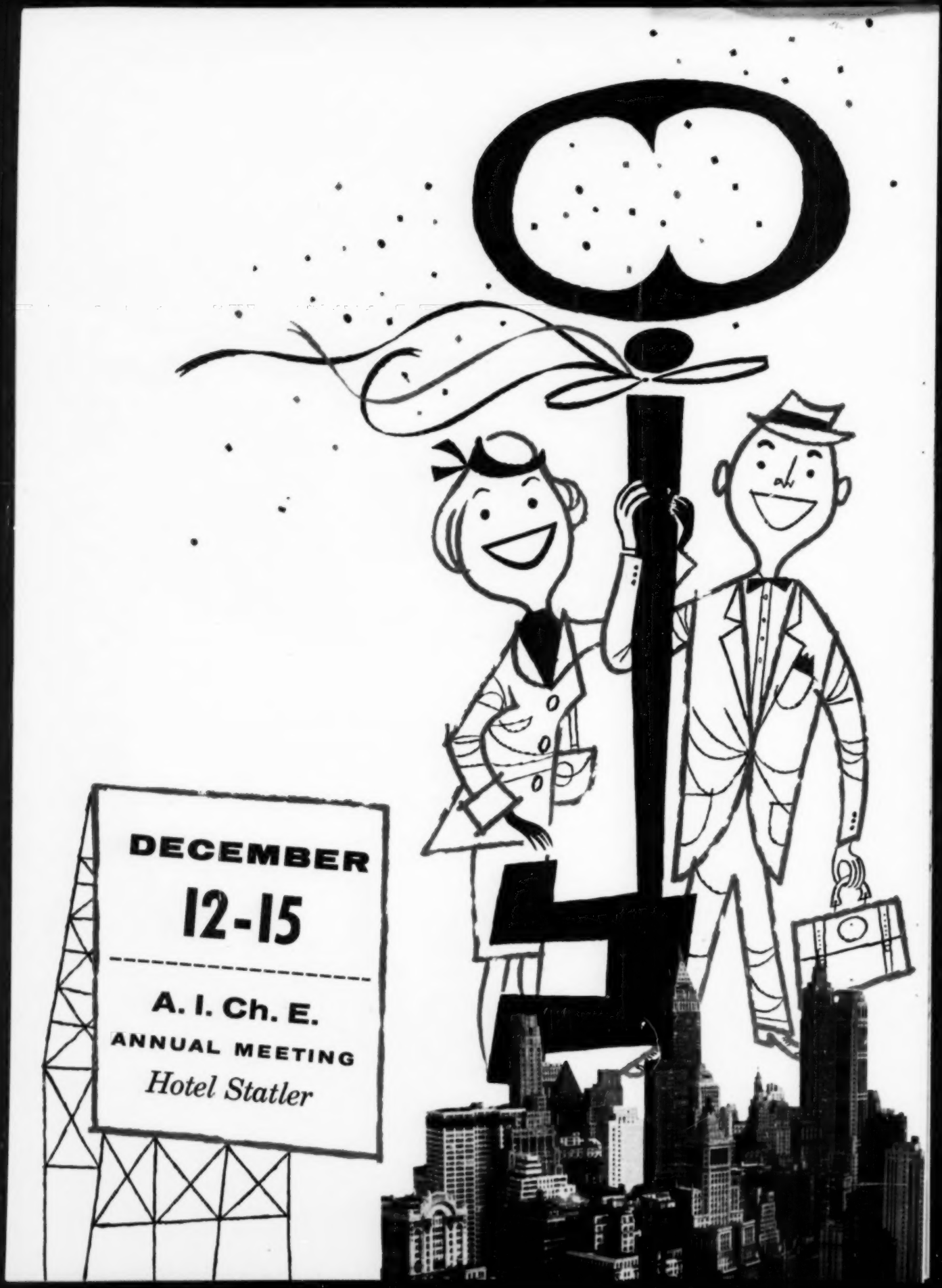
Brother, the City's yours!



The New York and New Jersey sections invite you to New York City for the Annual A. I. Ch. E. meeting— December 12-15—at the Hotel Statler.






DECEMBER
12-15
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ANNUAL MEETING
Hotel Statler

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HEADING THE LIST

is an extensive program of technical symposia including corporate organization, reaction kinetics, gas absorption, solvent extraction, new processes utilizing moving beds, and biochemical engineering. Of great importance will be a general forum, Sunday afternoon, on the problems of young engineers growing into management.



MAKE FRIENDS WITH IMPORTANT PEOPLE

at the meeting itself, visit them in their own offices, or tour with them on one of the 17 Big Plant Visits:

AUTOMOBILES–Lincoln-Mercury Assembly Plant
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CHEMICALS–American Cyanamid
EQUIPMENT–M. W. Kellogg
MATERIALS–Johns-Manville
OIL–Esso; California Oil; Socony-Vacuum
PAINT–Devoe & Raynolds
PEACE–United Nations
PHARMACEUTICALS–Hoffmann-La-Roche, Chas. Pfizer
RESEARCH–Bell Telephone; Celanese
SOAP–Colgate-Palmolive
SUGAR–American Refining



TV ENTHUSIASTS, ATTENTION!

"What's My Line" is being taken over by the Institute! The entire studio for this nationwide telecast is yours exclusively; and one of you may sit beside John Daly, trying to stump the panel.

SOMETHING FOR THE GIRLS

The Ile de France will wait proudly in port for you to visit her . . . see the U. N. and lunch in the Delegates' Room . . . enjoy the breakfast Fashion Show at Altman's and check Dior's latest . . . see Lever House, the breath-taking office building that made history . . . visit amazing Macy's Bureau of Standards . . . join the special matinee Theatre Party.



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Buying or selling, New York is your town . . . time is no problem in this compact city . . . visit equipment suppliers, service firms, and process operators.

HONOR COLUMBIA!

Officials of the Institute and leaders of industry and education will pay tribute to this great university at the Bicentennial luncheon on Tuesday.



YOUR HOST: THE INSTITUTE

A. I. Ch. E's new headquarters will proudly roll out its red carpet to welcome everyone. Enjoy the free Cocktail Party with sensational entertainment, dance at the Annual Banquet, and revel in Sunday's gala buffet get-together in the Cafe Rouge.

Cont'd.

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for further information, check box on post card opposite page 48

The 47th Annual Meeting has packed a blend of business and pleasure into four full days planned just for you. So, come to New York—stay at the Statler —enjoy yourself!



Pictures and brief biographical sketches of candidates for election are presented especially for the benefit of Members and Associate Members, to whom ballots are being mailed from the office of the Executive Secretary.

candidates for office

for president



J. Henry Rushton

Professor of chemical engineering at Illinois Institute of Technology, Dr Rushton is also a consulting chemical engineer serving the A.E.C., Mixing Equipment Co. and others. He has served on a number of Institute committees, and is currently a director, member of council, and chairman of the committee on Future of the Institute. Won the Wm. H. Walker Award, 1952.



Barnett F. Dodge

Professor of chemical engineering and head of the department at Yale University, Dr. Dodge has had a long and varied experience in both teaching and industrial consulting. He has lectured in France and Spain and been a member of a mission to Japan. Currently, Dr. Dodge is vice-president of the Institute and a member of the Awards Committee. Won the Wm. H. Walker Award in 1950.

for vice-president



Arthur K. Doolittle

Assistant director of research, Carbide and Carbon Chemicals Corp., So. Charleston, W. Va. Mr. Doolittle has had an extensive industrial experience, particularly in the field of surface coatings. He was a co-founder of the Charleston Section of the Institute, was its chairman in 1943-44. He is now a national director and Institute representative on E.J.C. Committee on Employment Conditions.



R. Paul Kite

Manager, Development Dept., The Dorr Company, Stamford, Conn. Mr. Kite has been long active in the fields of hydraulic classification, fluidization and related subjects. Formerly a director of the Institute; now A.I.Ch.E. representative with United Engineering Trustees on National Engineering Headquarters, Mr Kite had served as chairman of the Admissions Committee.

for treasurer



George Granger Brown

Consulting chemical engineer, professor of chemical engineering and dean, College of Engineering, University of Michigan. Dr. Brown is in the midst of a distinguished career in teaching, consulting, administration, and as an author. A past-president of the Institute, he is currently treasurer, director and member of the Chemical Engineering Education and Accrediting Committee. Won the Wm. H. Walker award in 1939; Hanlon Award in 1940.

please note

Stephen L. Tyler is retiring as Executive Secretary of the Institute at the end of 1954 and has declined to accept nomination for Secretary. F. J. Van Antwerpen has been appointed by the Council to succeed him as our Executive Secretary.

for secretary



F. J. Van Antwerpen

Publisher of the American Institute of Chemical Engineers. Mr. Van Antwerpen has been editor of "Chemical Engineering Progress" since its founding, and responsible for all publishing activities. Chairman of Public Relations Committee 1944 through 1947, and vice-chairman since 1948. He has also been active in the Publication Board; and Publication, Nuclear Energy, Awards, Program and History of the Institute Committees. Is serving Institute interests in the A.S.A., A.E.C. and E.J.C.

candidates for office

for directors

three-year term

** Nominated by petition.*



Edgar B. Chiswell

Chief process engineer, California Research Corporation, Richmond, Calif. Dr. Chiswell is a graduate of M.I.T., from which he entered a career in the petroleum refining industry. He participated in organizing the Northern California Section, in which he has held several offices. A member of the Public Relations Committee Dr. Chiswell has had responsible roles in recent West Coast meetings.



William A. Cunningham*

Chairman, Dept. of Chem. Eng., University of Texas. Dr. Cunningham has been at the University since 1941. His industrial experience has included Texas Pacific Coal & Oil Co, Freeport Sulphur Co., Texas Potash Corp., and University Lands. Has been a member of South Texas Section since its formation, and has held several offices. Serving on Professional Legislation and Industrial Waste Disposal Committees; was chairman of Committee on Arrangements for the Houston meeting, 1950.



Joseph H. Koffolt

Professor of Chemical engineering and chairman of the Dept., The Ohio State University. Dr. Koffolt received varied industrial experience before joining the University staff in 1929. He is consulting chemical engineer to the U.S. Government as well as a number of industrial firms. He is a member of the Local Section, Membership, and Equipment Testing Procedures Committees, and has served in a number of capacities with the local section.



Howard L. Malakoff*

Technical Manager, Petroleum Chemicals, Inc. (N.Y.) Dr. Malakoff has had a background of teaching prior to his entry into the petroleum refining industry in 1943, at which time he began a long connection with Cities Service Oil Company. He has held several posts in the Oklahoma and New York Section, and has been a member of the Program, Local Section and Research Committees. He is general chairman of the New York annual meeting, 1954.



Roy W. Sudhoff

Assoc. director of development, The Chemstrand Corp. (Decatur, Ala.). Mr. Sudhoff is a graduate chemical engineer from Washington University, St. Louis. In 1928 he began a long career with Monsanto which took him through production, engineering, and research. In 1952 he joined Chemstrand. He has served for several years on the Admissions Committee.



William S. Brackett

Vice-president, Carbide and Carbon Chemicals Company, So. Charleston, W. V. Mr. Brackett started his career with Carbide in its engineering department immediately following receipt of his M.S. at M.I.T. in 1923. Since then he has risen through several positions to his present responsibility. Mr. Brackett was the founder of the Charleston Section of the Institute and has recently been active in professional development work.



Raymond L. Copson

Director of research, Mutual Chemical Company of America, Baltimore, Md. Dr. Copson taught chemical engineering at Yale, from which he went to Socony-Vacuum, T.V.A., and Rumford Chemical before joining Mutual. He was chairman of Subcommittee on Student Contest Problem in 1936, and since then has been a member of the Education Projects, Publications, Program and Awards Committees, chairman of the Maryland Section, 1951-53.



Donald L. Katz*

Professor of chem. eng. and chairman, Dept. of Chem. & Met. Eng., University of Michigan. Dr. Katz is also consulting engineer to some thirty industrial firms. Has been long active in Student Chapter, Program, Nuclear Energy, Publication, Chemical Engineering Education and Accrediting Committees, also Subcommittee on Judging Presentations. Presently chairman, Division of Nuclear Engineering. Won Hanlon Award in 1950.



Walter E. Lobo*

Director of Chemical Engineering Div., The M. W. Kellogg Company. Mr. Lobo has served in industry since receiving his degree from M.I.T. in 1926. His connection with the Kellogg Company began in 1929. He has served on the Awards, Publication, and Program (Chairman 1950-52) Committees, as well as a number of meeting and symposia committees. He is currently chairman of the Research Committee.



Frank J. Smith*

General Manager, Pan American Chemicals Div., Pan American Refinery Corp. (N.Y.). Mr. Smith gained a broad industrial experience in petroleum refining and organic chemical manufacture before joining Pan American in 1942. He has been chairman of the 1946 Houston meeting, of the Program Committee for the 1951 Atlantic City meeting, and has served on the Program Committee.



Robert E. Zinn

Professor of chem. engr., Northwestern Univ. (Evanston, Ill.); Partner, Vern E. Alden Co. (Consultants, Chicago, Ill.). Mr. Zinn received much of his industrial experience with Victor Chemical Works, where he served as chief engineer from 1944-51. He has been a chairman and director of the Chicago Section, and has served on its By-Laws Committee, Professional Licensing Committee; and the Institute's Committee on Equipment Testing Procedures (Pumps).

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industrial news

SUN OIL TO PRODUCE ANHYDROUS AMMONIA

A $9,000,000 anhydrous ammonia plant employing only a single converter for the entire output is being designed and engineered by Catalytic Const. Co. for the Sun Oil Co. 300 tons per day of this important chemical will be produced in a plant at Marcus Hook, Pa., which has the most advanced process for the production of anhydrous ammonia.

The process will utilize by-product hydrogen gas from Sun Oil's Houdriformer units. The gas will be purified by means of a low temperature nitrogen wash system recovering usable hydrocarbon constituents for refinery re-run. Pure nitrogen from an air separation plant will be added to the purified hydrogen stream and compressed to approximately 4,000 lbs. for ammonia synthesis.

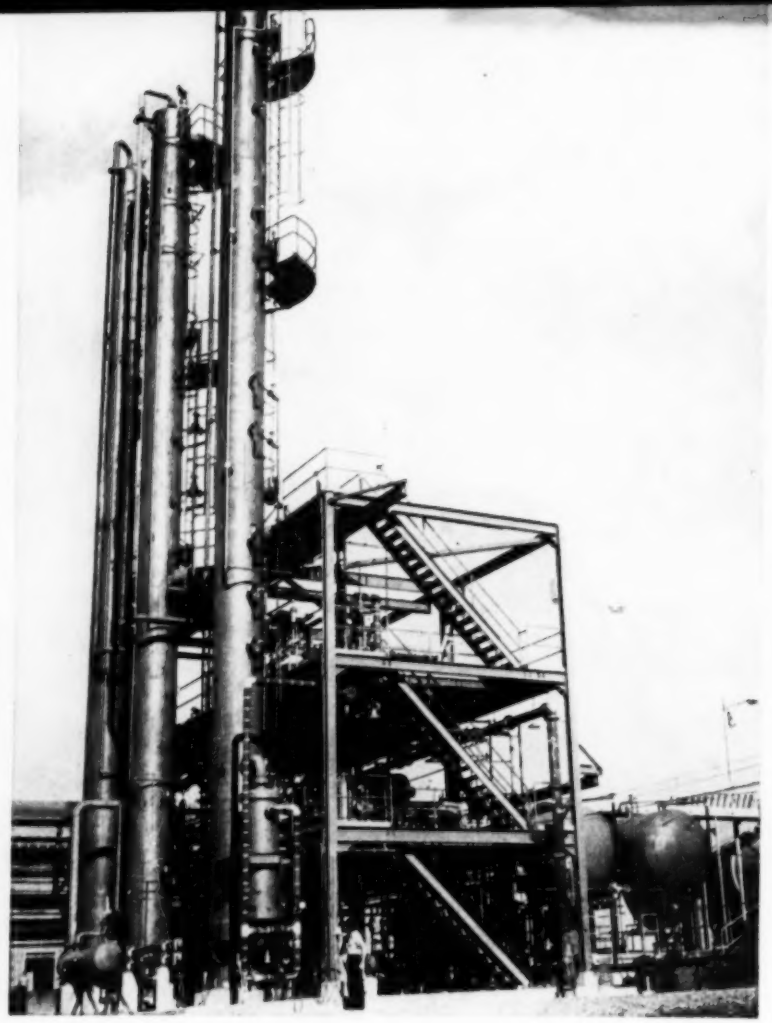
CSC CONSTRUCTS NITROPARAFFIN PLANT

As a first major step in an expansion program $5,000,000 is being spent by Commercial Solvents Corp. for construction by Ford, Bacon and Davis Const. Corp. of a new large-scale nitroparaffin plant at Sterlington, La. In addition CSC has undertaken an expanded research program to investigate new uses for the several hundred aliphatic hydrocarbon derivatives which have been prepared and show promise.

FIRST LINDE-FRAENKL PROCESS IN U. S.

The first Linde-Fraenkl cycle type of process to produce high purity oxygen in this country is being erected by the Blaw-Knox Co. for McLouth Steel Corp. at Trenton, Mich. A companion plant for the purification of crude argon from this plant is being designed.





SOLVAY PRODUCING CHLOROMETHANE

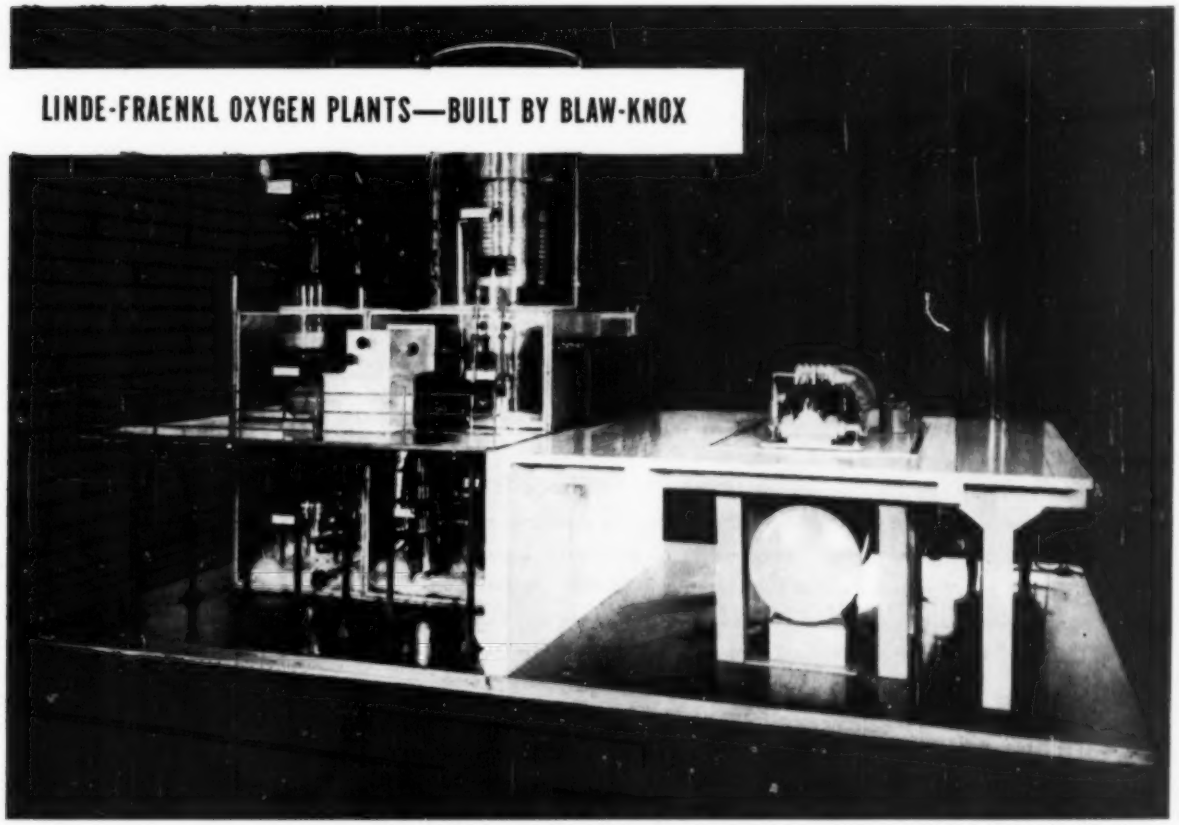
Combining natural gas from the "big inch" and chlorine from their new caustic producing plant, the Solvay Process Division of Allied Chemical and Dye Corp. has begun producing chloromethanes at Moundsville, W. Va. The new plant which looks like a modern petrochemical plant was engineered by Scientific Design Co. for flexibility of production output of methyl chloride, methylene chloride, chloroform and carbon tetrachloride. The proximity of methyl chloride and methylene chloride markets as well as a more economic location for some caustic soda outlets were considerations in the construction in Moundsville.

In this process chloromethanes are produced by reacting chlorine from the caustic soda plant with methane from natural gas at high temperatures in a reactor using a ratio of five volumes of methane or recycled gas to one volume of chlorine. The methyl chloride can be recycled up to a maximum content of 20% of the total hydrocarbon gas feed. Complete conversion of methyl chloride to higher chlorinated methanes is possible. The gaseous mixture of chlorinated methanes is scrubbed with water to remove the HCl formed in the reaction. After scrubbing the mixture of gases is neutralized with caustic, compressed and refrigerated. The separation is done by fractional distillation.

BREA USING GIRDLER REFORMING FURNACES

Two multi-tube reformer furnaces are included in the ammonia plant recently designed by the Girdler Co. for Brea Chemicals, Inc., a recently formed subsidiary of the Union Oil Co. of Calif. In the plant natural gas is steam reformed catalytically in these furnaces in the first step in the preparation of hydrogen for ammonia synthesis. The furnace effluent is further processed by CO conversion and liquid nitrogen scrubbing to obtain the desired purity of hydrogen.

LINDE-FRAENKL OXYGEN PLANTS—BUILT BY BLAW-KNOX



Scale model representing a 160 ton per day pure oxygen plant now under construction by Blaw-Knox.

all oxygen–99.5% pure at the lowest total operating cost of any tonnage oxygen unit available

Recent design improvements enable new Linde-Fraenkl plants to produce *all oxygen* at 99.5 percent purity at the lowest total operating cost of any tonnage oxygen unit available.

An average power consumption of only 450 horsepower hours is required to produce one ton of 99.5 percent oxygen. Such low power consumption is the result of excellent thermodynamic design and low pressure drops throughout the plant.

Simply designed regenerative heat exchangers maintain extremely close temperature differentials between inlet air and product gases. This is very important when as much as 40 percent of the total refrigeration required can easily result from only a few degrees difference in temperature between these gases. No chemicals are necessary to remove water and carbon dioxide.

The low pressure requirements of the plant reduce the costs of compressors, drives and auxiliaries.

Because of their advanced design, compact arrangement and relatively few moving parts, Blaw-Knox-built, Linde-Fraenkl units produce more oxygen of greater purity at the lowest total operating cost of any tonnage oxygen plants available. They are ideal for production of argon as a by-product.

If you are interested in low cost tonnage production of oxygen, write for Blaw-Knox Bulletin No. 2402.

BLAW-KNOX

BLAW-KNOX COMPANY *Chemical Plants Division*
Pittsburgh 22, Pennsylvania
Chicago 1, Illinois / Tulsa 1, Oklahoma

This Scrubber handles Hydrochloric Acid and Chlorinated Solvents at High Temperatures

..... Materials and Construction by EL CHEM

• The Tail Gas Scrubber shown at right is one of EL CHEM's recent installations in the chemical processing industries. This type of construction, planned, engineered and installed by EL CHEM, is used in plants producing organic chemicals.

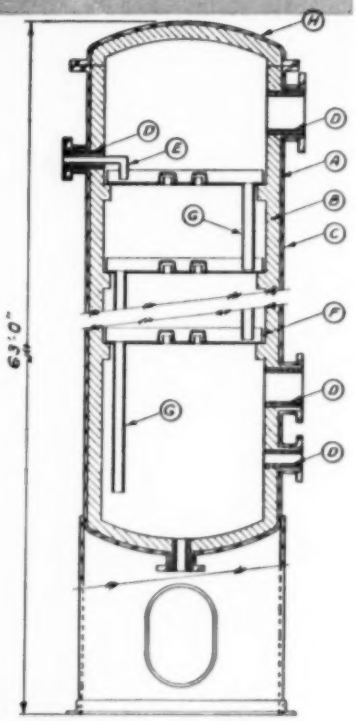
• It resists acids, *all alkalis* and most organic liquids. It features also high heat resistance.

• *All materials of construction* (listed below sketch) *are manufactured by* EL CHEM. Among them is LECITE, a recent development in Furfuryl Alcohol resin cement.

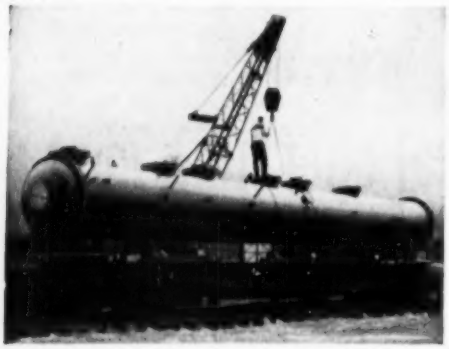
• As a corrosion-proof bonding agent, LECITE combines the desirable properties of the phenolics, without their drawbacks. It serves also as an impervious liner, when reinforced with glass cloth or metal mesh, as mortar for corrosion-proof brick lining and as an impervious membrane between brick or tile floor and the concrete sub-base.

• LECITE is used in the construction of acid-proof floors, chemical process equipment, such as scrubbers, reactors, storage tanks, filters, alkylators, neutralizing tanks, stacks and fume ducts.

• LECITE has been used successfully for many years in plants producing chemicals, dyes, Viscose, nylon, textiles, synthetic resins, petroleum products, steel, copper and many others.



(a) EL CHEM combination membrane
(b) One layer acid-proof brick, joined with LECITE acid-, alkali- and solvent-proof resin cement
(c) Welded steel shell
(d) Porcelain sleeve
(e) DURO-WARE inlet pipe
(f) DURO-WARE bubble cap tray (see picture at left)
(g) DURO-WARE downcomer
(h) Brick-lined removable dished head



Assembled at our Emmaus plant, shipped out by rail and installed by us at destination.



DURO-WARE bubble cap tray (f) in drawing at right.

EL CHEM renders a complete, all-inclusive service: materials, plans, engineering and installation. Our engineers will survey your corrosion problem, make recommendations and prepare plans and estimates — without obligation. At your command here is the benefit of more than four decades of experience in solving about every kind of problem in industrial corrosion. *Write for technical literature.*

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CAST HEAT ALLOY REFERENCE SHEET

N. S. MOTT, Chief Chemist and Metallurgist

The Cooper Alloy Foundry Co., Hillside, N. J.

Alloy: Heat Resistant 25% Chromium 20% Nickel Alloy.

Designations: A.C.I. HK; A.S.T.M. A297-49T Grade HK; S.A.E. 70310.

Chemical Analysis: C 0.20-0.60% Cr 24-28%; Ni 18-22%; Si < 3%.

Applications: Best all around alloy for high temperature service. Used for load-carrying members; pots; fixtures; calcining tubes; belt and chain links; feed pipes; fixtures; baskets and boxes.

Machinability: Machines fraily well.

Heat Treatment: Used in "as-cast" condition.

Weldability: May be readily welded using a type 310 welding rod. Some tendency to weld cracking. No heat treatment necessary after welding.

TYPICAL MECHANICAL AND PHYSICAL PROPERTIES

	Room Temperature		1200° F.	1400° F.	1600° F.	1800° F.
	As Cast	Aged *				
Tensile Strength, 1,000 lb./sq.in.	78	87	47	29	23	11
Yield Point, 1,000 lb./sq.in.	56	57	18	19	11	6
Elongation, %	19	12	21	11	21	24
Reduction in Area, %	23	14	31	20	35	17
Brinell Hardness	168	192				

* 24 hr. @ 1400° F. furnace cooled.

Charpy Impact (Std. Keyhole ft.-lb.)	12					
Mod. of Elasticity (X10⁶ lb./sq.in.)	29					
Density (lb./cu.in.)	0.280					
Melting Point (° F.)	2550					
Specific Heat (B.t.u./(lb.)(° F.)) @ 70° F.	0.12					
Thermal Expansion (x 10⁶ in. (in.) (° F.)) ° F.	70-1000	9.2				
	70-1500	9.7				
	70-2000	10.6				
Thermal Conductivity (B.t.u./(hr.) (sq.ft.)(° F/ft.)) ° F.	70-212	8.2	70-1500	11.9		
	70-1000	10.9	70-2000			
Electrical Resistance (microhms/cu.cm.) @ 70° F.	90					

HIGH TEMPERATURE STRENGTH: (lb./sq.in.)	1200° F.	1400° F.	1600° F.	1800° F.	2000° F.
Stress Rupture (100 hr.)		14,500	8,400	4,900	2,750
Stress Rupture (1000 hr.)		9,000	5,000	3,000	
Creep (1% 10,000 hr.)		6,500	4,700	2,700	1,100

MAX. (° F.) TEMPERATURE FOR CORROSION RESISTANCE:

Air Oxidation Resistance	2150
Oxidizing Sulfur Bearing Flue Gas (Low Sulfur)	2150
Oxidizing Sulfur Bearing Flue Gas (High Sulfur)	2050
Reducing Sulfur Bearing Flue Gas (Low Sulfur)	2150
Reducing Sulfur Bearing Flue Gas (High Sulfur)	1900

High Temperature Corrosion Resistance:

Molten Drawing and Tempering Salts ..... Good
Molten Cyaniding Salts ..... Good
Molten Neutral Salts ..... Good
Molten High Speed Salts ..... Good
Molten Metal Resistance .... Good resistance to molten lead. Not resistant to molten aluminum or magnesium.

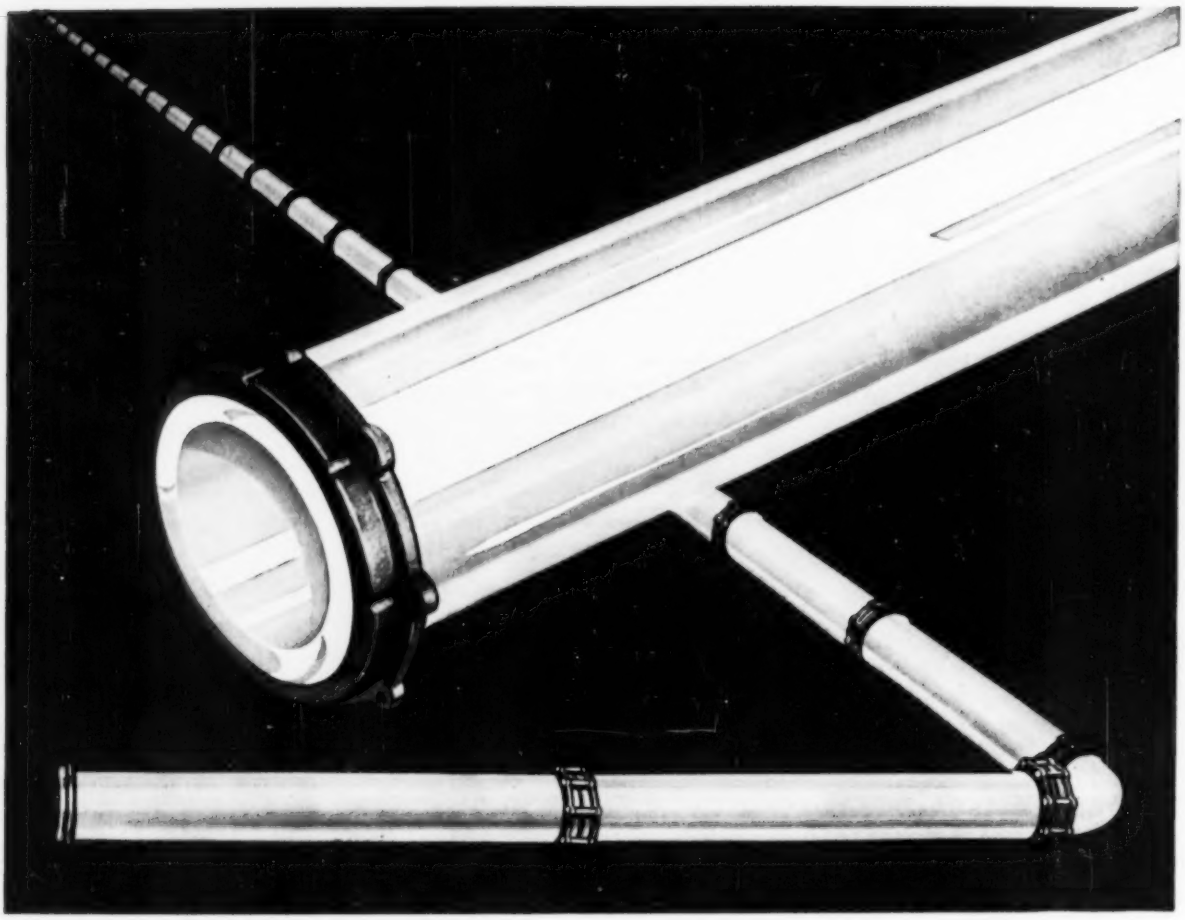
Carburization Resistance:

Pack Carburizing ..... Fairly good
Gas Carburizing (< 15% CH_4) . Excellent
Carburizing in Natural Gas (High CH_4) ..... Fair

General High Temperature Characteristics:

This alloy has the greatest high temperature strength of all the alloys but generally has low ductility. Thermal fatigue behavior is somewhat erratic but resistance to the effects of cyclic heating is good. Its hot impact resistance is fair and its hot hardness is high.

No. 39



For some applications ONLY CHEMICAL CERAMICS *will do*

For only chemical ceramics will resist all acids, alkalies and all solvents (with the exceptions of fluorides and hot caustics). White chemical porcelain, in particular, offers important processing advantages. In addition to its chemical inertness, white chemical porcelain is completely non-toxic and non-contaminating. Its smooth glazed surface makes cleaning a matter of minutes. It can be fabricated in one-piece construction into vessels of practically any shape and in sizes from a thimble to a thousand gallon tank. Many items of equipment, such as pipe, valves, fittings, sinks, filters and storage vessels are standard items carried in stock and ready for immediate shipment. Other items can be fabricated on short notice.

The United States Stoneware Company has been one of the world's principal producers of chemical ceramics for more than ninety years. Continual research and improved manufacturing techniques give today's chemical ceramics characteristics far superior to those of even a few years ago: better heat-shock resistance, higher mechanical strength, closer dimensional tolerances.

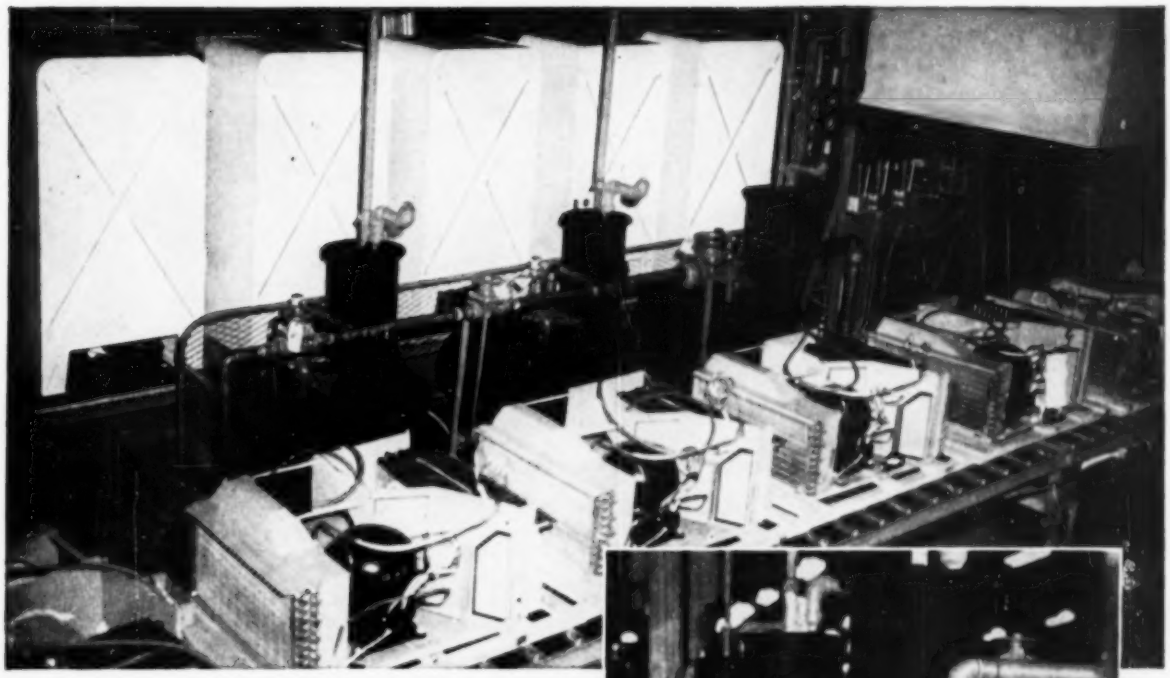
Better take a fresh look at chemical ceramics. It may pay you well.

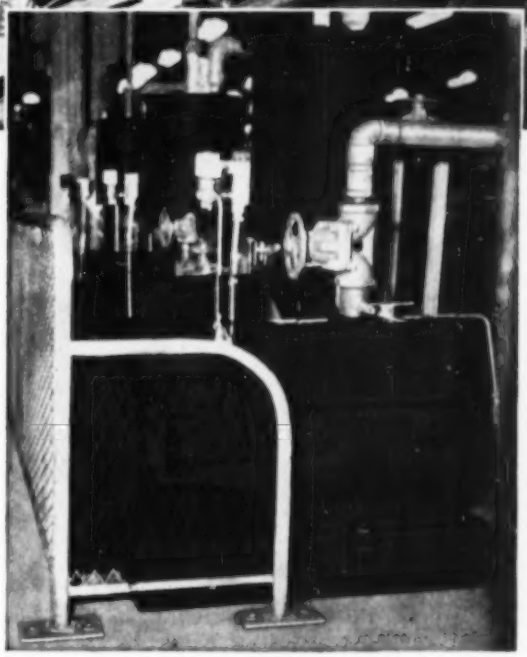
PRODUCT OF U.S. STONEWARE

PROCESS EQUIPMENT DIVISION

499-D

Other Corrosion-Resistant materials manufactured and fabricated by U. S. Stoneware and its affiliated companies, include: TYGON Plastics, Duralon Resins, natural and synthetic rubber products, lead-lined equipment, adhesives and organic bonding agents, acid-brick and cements, and sintered metallic oxides.





FAST VACUUM speeds production at Amana

Amana Refrigeration, Inc., manufacturer of air conditioning and refrigeration units at Amana, Iowa, keeps production rolling with Kinney High Vacuum Pumps. During their many years of service at Amana, Kinney Pumps have fully demonstrated their reliability, ease of operation, and economy of maintenance. Here, as in hundreds of major vacuum processing systems throughout the country, Kinney Pumps create low absolute pressures fast and efficiently, and provide quick recovery speed for high production rates.

Whatever your vacuum problem — whether for laboratory, pilot plant, or full scale production — there's a Kinney Pump to fill your needs. Kinney district offices are staffed with competent vacuum engineers, ready to help you get the right vacuum pump for each application.

Send Coupon for Complete Details

Kinney

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3546 WASHINGTON STREET • BOSTON 30 • MASS.

☐ Please send Bulletin V54 describing the complete line of Kinney Vacuum Pumps.

☐ Our vacuum problem involves _____

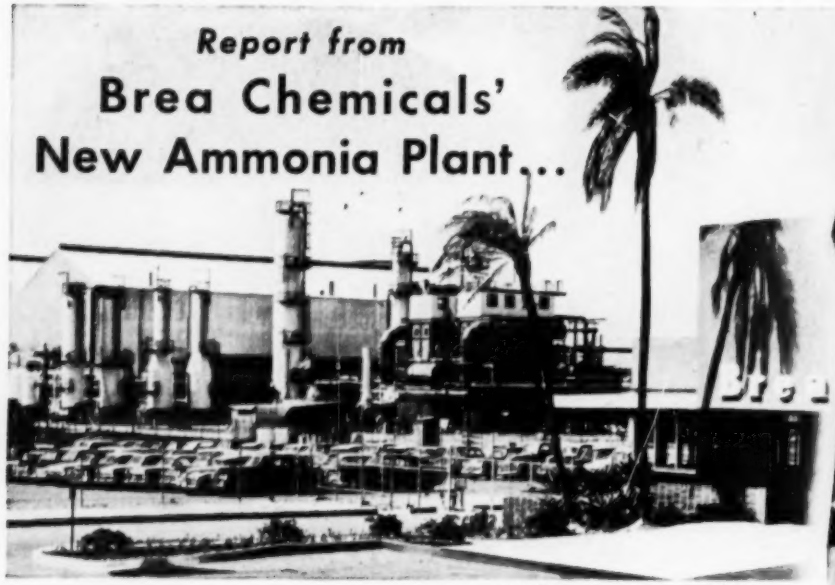
Name _____

Company _____

Address _____

City _____ State _____

Report from
Brea Chemicals' New Ammonia Plant...



C. F. Braun & Co., Engineers and Constructors



...on their *Air Products* Low-Temperature
LIQUID NITROGEN WASH UNITS
and Tonnage Oxygen-Nitrogen Generators

BREA CHEMICALS, INC.
P O BOX 128
BREA, CALIFORNIA

JACK TIELROOY
MANAGER OF DEVELOPMENT

Mr C J Schilling.
Chief Engineer,
Air Products, Inc
P O Box 538.
Allentown, Pa

Dear Mr Schilling

Our ammonia plant has now been operating for some time, and we want to let you know that we are well-pleased with the nitrogen production units and hydrogen purification units you supplied to us.

The units produce nitrogen with a purity of 99.99% and hydrogen-nitrogen mixtures with a purity of better than 99.999% at rates considerably over "design".

The prompt availability of your engineers for consultation at the site was indeed a real assistance during our start-up and is very much appreciated. The help they gave us was of real assistance in achieving an early "on-stream" date.

Yours very truly,
BREA CHEMICALS, INC.
Jack Tielrooy
Jack Tielrooy,
Manager of Development

AIR PRODUCTS built two of these "Package" hydrogen purification units using nitrogen wash and two oxygen-nitrogen producing units for Brea Chemicals, Inc., a subsidiary of Union Oil Company of California. "Package" Nitrogen Wash Units are available from *Air Products* with capacities to 10,000,000 cubic feet per day. Larger plants with greater capacities are also available. Both types are designed and built to meet individual requirements.

For further information on hydrogen purification plants . . . oxygen-nitrogen generators . . . other low-temperature processing units for gas separation . . . write or phone *Air Products, Incorporated, Dept. U, Box 538, Allentown, Pa.*



Send for 36-page brochure, "Low-Temperature Processing"

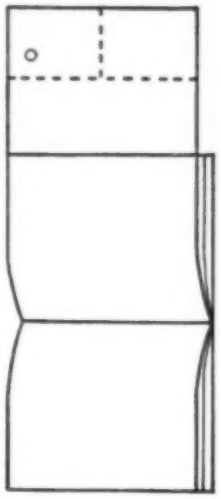
Air Products
INCORPORATED

Specialists in Low-Temperature Processing

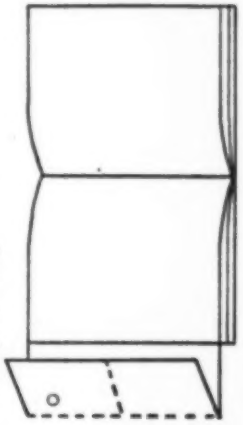
for. your information

This C.E.P. information service is a convenient way to get the chemical engineering information you need on the new equipment, on advertised products, on the newly announced developments reported on these pages. A one post card inquiry designed to bring data quickly and easily. Circle the items of interest, sign your name, position, address, etc., and drop in the mail.

Just a moment is needed to learn how to use this insert. When looking through the front part of the magazine pull the folded portion of the insert out to the right, and the numbers on the post card are convenient for marking. THEN . . .



as you pass the pull-out page, and it is on the left, fold the post card back along the vertical scoring, and once again the numbers are handy for circling.



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CHEMICAL ENGINEERING PROGRESS
25 West 45th Street
New York 36,
New York

PRODUCTS

IFC **Columbia Activated Carbon System.** Recovers almost any low-boiling solvent or solvent mixture. A. B. Dick plant described. Carbide and Carbon Chemicals Co.

3R **All-Metal Rotary Sifter.** Motor-driven unit for making particle-size separations on most dry, powdered, granular, flaked or crystalline materials. B. F. Gump Co.

4L **Process Instrumentation.** For measuring flow, liquid level and differential pressures. Barton Instrument Corp.

5A **12 in. Centrifugal.** For laboratory tests . . . and small batch production. Choice of 3-speed motor drive or "all-speed" hydraulic drive. Tolhurst Centrifugals Div., American Machine and Metals, Inc.

6A **Clamp Gate Valves.** Designed for hard to hold fluids. All iron or brass-trimmed. Crane Co.

7A **NH_3.** Manufacturer declares "know how," cites 765 tons/day NH_3 "know how." Bulletin. Foster Wheeler Corp.

8L **Filters.** Horizontal plate filters. Versatile adaptability for difficult filtering problems. Sparkler Manufacturing Co.

9A **Valves.** Solid, unfilled Teflon, in a wedge-ring arrangement, provides a packing for Lapp porcelain valves. Lapp Insulator Co., Inc.

10A **Horizontal Closed Circuit Conveyor.** Simultaneous pick-up or discharge at one or many points. Stephens-Adamson Mfg. Co.

11A **Nitric Acid Installation.** Description of installation built by Girdler at Mississippi Chemical Corporation's ammonium nitrate plant. The Girdler Co.

12L **Sump Pump.** Multi-stage and centrifugal diffusion vane construction. Can pump up to 350 ft. of head. Johnston Pump Co.

13A **Flakers.** Buflovak flaker handles toxic materials. Provides continuous operation and large capacity. Catalog. Buflovak Equipment Div., Blaw-Knox Co.

14A **Heat Exchangers.** Installation sub-cools aniline after it has been condensed. Also expansion joints, traps, strainers, and separators. American District Steam Co., Inc.

15A **Filters.** Continuous vacuum filters using compression blankets. Produces a flocculent solid type cake. The Eimco Corp.

16A **Liquid Filters.** For water, chemicals and petroleum products. Bulletin. Dollinger Corp.

17A **Any Rev./Min. Motor.** 14¼ in. high. ¼ to ¾ hp. U. S. Electrical Motors Inc.

18A **Ion Exchange Resins.** Resins remove ash from cane sirup solutions. Also for purification of gelatin, amino acids, fruit drinks, etc. Rohm & Haas Co.

19A **Valves and Valve Lubricants.** "Internal lubrication system eliminates most reasons for valve failure," manufacturer states. Nordstrom Valves Div., Rockwell Manufacturing Co.

21A **Rotary Kiln.** Provides smoke-free disposal of waste. Also dryers, coolers, and calciners. The C. O. Bartlett & Snow Co.

22L **Plastic Pumps.** For difficult corrosive solutions and abrasive slurries. Vanton Pump & Equipment Corp.

23A **Dryers.** "Small, laboratory-size Louisville dryers produce sufficient quantities to supply the market," manufacturer states. Louisville Drying Machinery Unit, General American Transportation Corp.

24A **Centrifugal Processing.** Manufacturer describes his line of 7 different types of centrifuges. Bulletin. The Sharples Corp.

25A **Control of Process Heat.** Heat transfer medium maintains temperature within a fraction of a degree. Used as a vapor heating medium in a closed system. The Dow Chemical Co.

26A **Pumps.** Combined pump and motor, sizes from ⅛ to 7½ hp., in a wide variety of construction materials. Chempump Corp.

27A **Crystallization Equipment.** Applications of crystallization equipment. Continuous or batch operation. Struthers Wells Corp.

28L **Oil Reclaimer.** Equipment for reclaiming, filtering, purifying and re-refining oil. The Hilliard Corp.

28R **Books.** "Fresh Water from the Ocean," "Titanium," "Electrolytic Manganese and Its Alloys," and "The Evolution of Chemistry." The Ronald Press Co.

29A **Pumps.** Moves a few gallons of fluid . . . or up to 2,800 gal./min. with heads to 650 feet. Ingersoll-Rand Co.

30L **Packings.** Packings for valves made of Teflon. Also pump packings of Teflon, Teflon with graphite and Teflon with mica. United States Gasket Co.

31A **Graphite Anodes.** Graphite anodes for the electrolytic industry in making chlorine and caustic soda for anti-knock compounds. Great Lakes Carbon Corp., Electrode Div.

32A **Celite.** Mineral filler for extending, dispersing or fluffing up dry powders. Johns-Manville

33A **Filtration Problem.** Pilot filters are available for a rental fee, to try before you buy. Niagara Filters Div., American Machine and Metals, Inc.

34A **GATX Tank Cars.** Service for transporting liquids in bulk. Tank Car Div., General American Transportation Corp.

534A **Extractive Metallurgy.** Minerals beneficiation and extractive metallurgy methods. Help supplied to research and production teams. Bulletins and ideas. Turbo-Mixer Div., General American Transportation Corp.

41A **Gasholders.** Dry fabric seal eliminates maintenance problems. Wiggins Gasholder Div., General American Transportation Corp.

43A **Oxygen Plants** Features scale model of 160 ton per day pure oxygen plant under construction. Blaw-Knox Co., Chemical Plants Div.

44A **Tail Gas Scrubber.** Used in plants producing organic chemicals. Electro Chemical Engineering & Mfg. Co.

46A **Chemical Ceramics.** For use in resisting most acids, alkalies and solvents. High heat stock resistance. U. S. Stoneware Co.

47A **High Vacuum Pumps.** Create low absolute pressures fast and efficiently. Quick recovery speed for high production rates. Kinney Mfg. Div., The New York Air Brake Co.

Chemical Engineering Progress

Numbers followed by letters indicate advertisements, the number corresponding to the page carrying the ad. This is for ease in making an inquiry as you read the advertisements. Letters indicate position—L, left; R, right; T, top; B, bottom; A indicates a full page; IFC, IBC, and OBC are cover advertisements.

Be sure to give name, address, position, etc.

Remember, the numbers on the upper portion of the card bring you data on only the bulletins, equipment, services, and chemicals reported in these information insert pages. The lower portion of the card is for the advertised products, and is keyed not only to advertising pages, but also to the memory-tickling list under the heading Products.

48A **Hydrogen Purification Plants.** Also oxygen-nitrogen generators and other low-temperature processing units for gas separation. Air Products, Inc.

53A **Spray Drying.** Spray dryer producing a sterile dextran product. Bowen Engineering, Inc.

57A **Catalyst Supports.** Seventeen compositions, three degrees of porosity, symmetrical or poly-surface pellets. The Carborundum Co.

59A **Stainless Steel Products.** Custom castings, jet engine rings, valves, fittings and accessories. The Cooper Alloy Corp.

61A **Drying Problems.** Drying research laboratory services. C. G. Sargent's Sons Corp.

62A **"Tel-O-Set" Instruments.** A family of miniature recorders and controllers. Minneapolis-Honeywell Regulator Co.

65A **Conveyor Dryers.** A large multiple-unit, multiple apron dryer; and, a fourteen-section multiple unit, single apron machine are illustrated. The National Drying Machinery Co.

66L **"Thermomill."** The Hardinge "Thermomill" is a combination of conical mill, air classification system and air preheater. It dries, grinds and classifies. Hardinge Co., Inc.

67A **Plant and Unit Design.** Electrical, mechanical, steam, power, hydraulic and structural engineering. Badger Mfg. Co.

68L **Mixers.** Manufacturer stresses continuous service and low maintenance cost as characteristics of Abbé mixers. Paul O. Abbé, Inc.

(Continued on back of this insert)

Please do not use this card after February, 1955

1	2	3	4	5	6	7	8	9	10	11	12	14	15
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Advertisers' Products

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21A	22L	23A	24A	25A	26A	27A	28L	28R
29A	30L	31A	32A	33A	34A	534A	41A	43A
44A	46A	47A	48A	53A	57A	59A	61A	62A
65A	66L	67A	68L	69A	70L	71A	72L	73A
74L	75A	76L	77R	78T	78B	79A	80T	80B
81A	82T	82B	83R	84L	85R	86L	87T	87B
88L	88R	89TL	89BL	89R	90B	91BL	91T	91BR
94L	94BR	95T	95B	IBC	OBC			

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☐ Send information on N. Y. meeting.

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115	116	117	118	119	120	121	122	123	124	125	126	127	128

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29A	30L	31A	32A	33A	34A	534A	41A	43A
44A	46A	47A	48A	53A	57A	59A	61A	62A
65A	66L	67A	68L	69A	70L	71A	72L	73A
74L	75A	76L	77R	78T	78B	79A	80T	80B
81A	82T	82B	83R	84L	85R	86L	87T	87B
88L	88R	89TL	89BL	89R	90B	91BL	91T	91BR
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City ..... Zone ..... State .....

☐ Send information on N. Y. meeting.

☐ I want a subscription. Bill me $6.00 for a year.

November, 1954

PRODUCTS *(Continued)*

69A **Pumps.** Made to pump highly abrasive slurry. Features solid porcelain plungers. The Aldrich Pump Co.

70L **Chemical Feeders.** Models for simultaneously feeding many different chemicals at rates from a few drops to 60 gal/hr./feed. Manzel Division of Frontier Industries, Inc.

71A **Yorkmesh Demisters.** Designed and constructed to effect clean separation between liquid and vapor, and increase the throughput capacity of vacuum towers. They consist of knitted fine wire mesh. Otto H. York Co., Inc.

72L **Heat Exchangers.** Pressure: 300 lb./sq.in. gauge; temperature: 1,200° F.; capacities: 750,000 to 8,000,000 B.t.u./hr. Other types. Thermal Research & Engineering Corp.

73A **Ni-Resist Plates and Frames.** Manufacturer asserts "Ni-Resist plates and frames in Shriver filter presses were good as new after eight years' use in filtering highly corrosive potash brine." The International Nickel Co., Inc.

74L **Exchangers.** Manufacturer offers special materials and special designs. Also condensers, coolers, etc. The Whitlock Manufacturing Co.

75A **Ammonia Valves.** Valve built to withstand 6,000 lb./sq. in. Also is manufactured for 15,000 lb./sq.in. Catalog. Autoclave Engineers, Inc.

76L **Photochemical Equipment.** Source for actinically sensitized high-pressure reactions. For production involving synthesis, decomposition, hydrolysis, hydrogenation, etc. Hanovia Chemical & Mfg. Co.

77R **Centrifugally Cast Pipe.** O.D. ranging from 2½ in. to 24 in. and lengths up to 15 ft. according to diameter. The Duraloy Co.

78T **Motors.** Vertical-hollow-shaft pump motor 3—200 hp. Designed for deep well irrigation and industrial pumping application. ACEC Electric Corp.

78B **Spray Nozzles.** Manufacturer recommends his "incomparable reference catalog." Spraying Systems Co.

79A **Glassed Steel Equipment.** Acid-alkali-resistant glass is now standard on glassed steel units for severe chemical service. The Pfaudler Co.

80T **Helix Potting Compound.** A thermosetting epoxy-based compound that cures at room temperature. Hermetically seals components against fungi, moisture, and acids. Carl H. Biggs, Co.

80B **Condensers.** Features 9,000 sq. ft. condenser for utility plant, and 3,500 sq. ft. condenser serving the turbine drive of the main air compressor in a refinery. Condenser Service & Engineering Corp.

81A **New A.I.Ch.E. Journal.** Circle card for subscription information about this new chemical engineering quarterly.

82T **Crushers.** Designed for capacities beyond those of lab mills and below those required for large-scale operations. Equipped with rings or any of a full variety of hammers. American Pulverizer Co.

82B **Tanks.** Glass reinforced polyester, epoxy, and phenolic laminates. Molders and fabricators. Carl N. Beetle Plastics Corp.

83R **Air Pollution Control.** New wind operated, automatic controller energizes forced draft or heat systems under unfavorable meteorological conditions . . . thereby increasing "effective stack height." Friez Instrument Div. of Bendix Aviation Corp.

84L **Antifoam A.** Odorless and tasteless silicone defoamer. Physiologically harmless in food at concentrations up to 10 p.p.m. Also Antifoam AF, a dilutable defoamer containing 30% Antifoam A. Dow Corning Corp.

85R **Tank Heaters.** Vertical mounting avoids heating through a layer of sediment. Brown Fintube Co.

86L **Pumps.** For volatile sludges and slurries. Lawrence Pumps, Inc.

87T **Protective Coatings.** Manufacturer stresses low cost method of meeting coating requirements. Booklet. Rowe Paint & Varnish Co., Inc.

87B **Special Processing Problems.** Resources for fabrication, including modern shop equipment or heavy sheet metal forming, specialty welding, and all machinery operations. Artisan Metal Products, Inc.

88L **Vacuum Jacketed Storage Vessels.** For storing, handling, and transporting liquefied gases. Also plants for the production of liquid oxygen, etc. Herrick L. Johnston, Inc.

88R **Mist Eliminator.** Liquid carry-over controlled by separators made of knitted wire mesh. Metal Textile Corp.

89TL **Surface Pyrometer.** For plant and laboratory surface and subsurface temperature measurements. Selection of thermocouples and extension arms. Pyrometer Instrument Co.

89BL **Steam Jet Ejectors.** Condensers and vacuum equipment. Corrosion resistant parts interchangeable with standard parts. The Jet-Vac Corp.

89R **Double Cone Blender.** Retractable charging and unloading device. Brake for accurate positive positioning. Motor or floor mounted. General Machine Co. of New Jersey

90B **Stirrers.** Electronic stirrer with thryatron tube control. Ace Glass, Inc.

91BL **Filters.** High pressure service up to 10,000 lb./sq.in. Micro Metallic Corp.

91T **Plasticizer Oil.** Compatibility with GRS, neoprene, and buna N type rubbers. Pan American Refining Corp.

91BR **Corrosion-Resistant Mortars.** For acid-and alkali-proof masonary in floors, tanks, sewers, towers, etc. Delrac Corp.

94L **Catalysts.** To selectively hydrogenate acetylene in the presence of ethylene. The Girdler Co.

94BR **Filters.** Features new catalog on filtration and its application. D. R. Sperry & Co.

95T **Process Engineering & Equipment Design.** Process engineers translate laboratory or pilot plant data into chemical plant, create equipment. Foster D. Snell, Inc.

95B **Evactors.** Illustration shows two 4-stage evactor units in pharmaceuticals plant. Also jet mixers, jet heaters, etc., Croll-Reynolds Co., Inc.

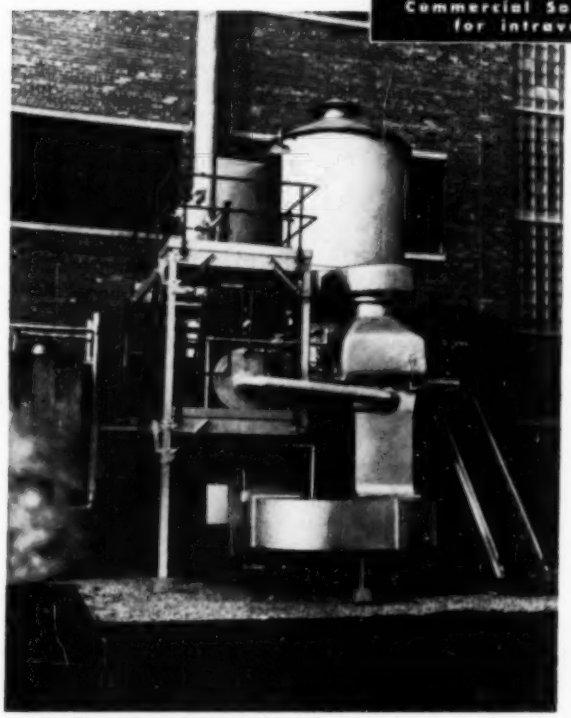
IBC **Controlled Volume Pumps.** Air-powered pumps have a capacity range of from .04 to 405 gal./hr. against pressures up to 25,000 lb./sq.in. Capacity can be varied manually or automatically. Milton Roy Co.

OBC **Fluid Mixers.** Turbine-type in sizes from 1 to 500 hp. and side entering sizes 1 to 25 hp. and portable sizes ⅛ to 3 hp. Mixing Equipment Co., Inc.

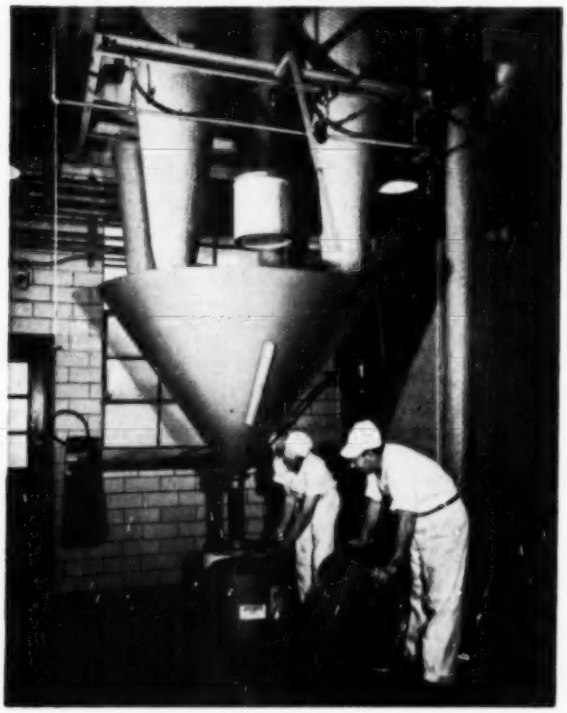
(Continued on page 54)

SPRAY DRYER PIONEER

Commercial Solvents meets difficult problem of sterile material for intravenous injection by use of Bowen Spray Dryer



The Bowen Spray Dryer producing the sterile dextran product, is installed out of doors. Ducts run into the building where product collectors and packaging room is located.



Commercial Solvents Produces New Plasma Volume Expander

Originally known as dextran, this product was developed during the war under a Swedish patent. Commercial Solvents, the first to have its product approved in the United States, replaced the original expensive vacuum tray dryer technique with the speedier, lower cost spray drying method. Although dextran was produced exclusively for the armed forces, it is now available under the trade name Expandex to the civilian market.

Recognition is due Commercial Solvents for making available its dextran to our armed forces in Korea and elsewhere and credit should be given to all personnel responsible for its development and production.

Bowen Engineering is proud to have had the opportunity of cooperating in this project.

BOWEN ENGINEERING, INC.

NORTH BRANCH 13, NEW JERSEY

BOWEN SPRAY DRYERS
Always Offer You More!

Recognized Leader in Spray Dryer Engineering Since 1926

EQUIPMENT

1 **Bag Flattener.** Available from Rapids-Standard Co. a power-driven Rapistan "BF" bag flattener. Kneads & flattens filled multiwall sacks into firm, space-saving packages. Unit removes air & distributes bulk materials evenly. Top unit is spring loaded, adjustable up & down to provide pressure on sacks. May be mounted next to filling machines or at any point on supply line.

2 **Portable Floor Machine.** Weighing only 38 lb., complete with 12-in. brush for use in buildings with no elevators; a portable floor machine from Premier Portable Floor Machine. ⅓ hp. G.E. 115 v.a.c. constant speed motor. Scrubs, waxes, polishes any floor.

3 **Wall Sterilizers—Utility Baths. (3)** For modern laboratories where space is limited Precision Scientific Co. has developed a flush-mountng assembly for Precision-Freas ovens, sterilizers & incubators. **(4)** Sero-Utility baths with higher temperature range & adjustable shelf. Stainless interiors & exteriors increase wattage 66% or more. Combine functions of serological & utility-purpose baths.

5 **Aluminum Alloy.** For conducting electricity Aluminum Co. of America have developed No. 2 EC aluminum alloy. Said to have superior mechanical properties with slight sacrifice in electrical conductivity over other types used for this purpose. Important for applications requiring high yield strength & low creep.

6 **Flexible Lining Material.** Called Vyflex L-10 corrosion resistant thermoplastic lining material combines good chemical, physical, & electrical characteristics. For use with common acids, alkalis, salts, plating solutions, at temperatures to 160° F. Available in black & white from Kaykor Industries, Inc.

7 **Ribbon Mixer.** Developed by the Stevenson Co. heavy duty horizontal type ribbon mixer for rapid blending of wet or dry materials. Sizes for volumes ¼ to 175 cu.ft. feature extra heavy one-piece end plate construction, oversized shaft, anti-friction roller bearings. Seal glands provide sufficient packing for dust or liquid applications. Built of stainless steel or any alloy required

8 **Fiber Glass Mats.** Announced by Bigelow Fiber Glass Products div. of Bigelow-Sanford Carpet Co., Inc., 84 in. wide mechanically bonded fiber glass mats. Said to be widest in the industry with usual drapability, formability & uniformity of Bigelow mats. Available in textured & untextured grades.

9 **Plastic Pipe.** Available in 10 & 20 ft. lengths, bell & spigot solvent cemented Schedule 40 & 80 plastic pipe. Based on high impact polyvinyl chloride, normal impact polyvinyl chloride, & styrene rubber plastic, with flanged & threaded ends. Sizes to 6 in. O.D. Plastic rod plus large sheets of various thicknesses also available. Atlas Mineral Products Co

10 **Steam Trap.** Said to be revolutionary in design & based on new principles, steam trap from Perfecting Service Co. Uni-Trap employs balanced valve principle, operates automatically through range to 250 lb./sq.in. without adjustment, orifice changes, or valves. Pipe size only needed to specify requirements. For process industries where load & pressure range vary. Folder describes types, shows cutaway views.

11 **Sanitary Pump.** For use in the food, & pharmaceutical industries. Said to offer radical departure from usual pump. Action isolates fluid from all actuating mechanisms or rotating parts. No internal sharp corners or crevices in fluid passage. Vanton Pump & Equipment Co.

12 **Stainless Steel Valves.** Introduced by Rockwell Mfg. Co. line of stainless steel lubricated plug valves for use in food, sulfite pulp & chemical plants. Chrome plating backed by stainless steel affords extra protection against scoring, galling; corrosion.

14 **Porous Teflon.** Corrosion resistant porous Teflon filter medium from Porous Plastic Filter Co. Mean pore size 9 microns; will filter all particles of diameters larger than 3 microns from liquids. Flow capacities to 45 gal./min./sq.ft. of filter at 5 lb./sq.in. differential pressure for organic fluids of 1 centipoise viscosity. Available in disc form sizes up to 12 in. diam. with solid Teflon rim.

15 **Hi-Pressure Meters.** Now in production by Bowser, Inc., two new Hi-Pressure XACTO meters of 15 & 50 gal./min. & pressures up to 500 lb./sq.in. Designed to give positive displacement accuracy on industrial liquid measuring jobs requiring high-pressure applications. Parts are stainless steel, have hard carbon bearings & Teflon pistons. Designed for either top or bottom mounting. Data available.

16 **Oxygen Analyzer.** Folder from Arnold O. Beckman, Inc., on model 1A3B dissolved oxygen analyzer. Provides accurate and continuous measurement in applications such as waste disposal, water treatment plants, solvent, chemical, petroleum products industries. Direct reading of per cent saturation. Scales available calibrated in parts/million. Diagrams, specifications.

17 **Auto-Stop Meter.** Automatic control of water, syrups, solvents, other liquid ingredients now accomplished by use of 3-in. Neptune Meter Co. Auto-Stop meter. Features double-trip valve which slows down rapid flow of liquid an instant before it trips shut; permits accurate cutoff without hydraulic hammer. Meter is positive displacement, nutating piston type & handles more than 150 different liquids. Bronze construction.

18 **Portable Mixer.** Portable mixer designed with an adjustable shaft announced by Alsop Engineering Corp. Outboard bearings are self-aligning, prelubricated type sealed against lubricant drip & leak. Hollow tube & chuck arrangement using locking sleeve provides quick positive shaft adjustment that does not loosen or jam. Shafts & propellers available of stainless steel, monel metal, other materials lead or rubber coated as required. Sizes 1/20 hp. to 7½ hp.

19 **Reducing & Relief Valve.** Designed for low capacity applications a high pressure combintion reducing & automatic relief valve from Atlas Valve Co. Known as Type F it can be used for initial pressures to 4,000 lb./sq.in. & reduced pressures from 2,000 lb./sq.in. down to zero in accurately controlled adjustable increments. Reduces high pressure air, oil or water to set point without shock. Will not leak on tight shutoff. Sizes ⅛ to ¾ in.

20 **Plastic Pipe.** Corrosion-resistant, rigid plastic pipe said to have great impact resistance & toughness from American Hard Rubber Co. Called Dur-Ace it is light in weight, odorless, tasteless, and non-contaminating. For use in range 0-40° to 170° F.

21 **Needle Valves.** Complete new line of forged needle valves with universal outlets & featuring micrometer thread stainless steel stems for fine metering announced by Carpenter Valve Corp. Known as Bull-Dog valves, bodies are forged from brass, stainless or carbon steel. Wide range of optional machinnigs on outlets said to facilitate lower-priced neat installations. Also furnished in mountings for instrument panels.

22 **Pressure & Temperature Measuring System.** Control Engineering Corp. have developed for industrial use an ElectroSyn pressure & temperature measuring system. Based on a signal generator of high resolution, electromagnetic, rotary transducer with linear output. Facilitates remote readings of temperatures & pressures without complex electronic circuits.

23 **Process Timer.** Featuring one-knob control is a process timer from General Electric Co. Model TSA-21 controls timed simultaneous closing of one circuit & opening of another. Applications include automatic mixing operations. Calibrated from 0 to 100%.

24 **Impervious Graphite Pump.** Falls Industries, Inc. recently redesigned line of Impervite centrifugal pumps includes a virtually leakproof pump seal fabricated from impervious graphite and features a simple, self-cooled rotary section easily accessible. Other advances are oversized bearings & heavy stainless steel shaft. Shaft & impeller are separate components permitting quick, simplified maintenance.

25 **Heavy-Duty Generator.** A 2-kw. ultrasonic power generator the Sonogen 2,000 developed by Branson Instruments, Inc. speeds cleaning & degreasing of parts made of metal, rubber, plastics, glass. Output is fed into barium titanate transducer at 100,000 cycles/sec. Units now in use clean electric motors, instrument parts, bearings, control & timing devices.

26 **Sectional Belt Conveyor.** Bulletin from Stephens-Adamson Mfg. Co. on complete set of belt conveyor components pre-engineered for customer assembly. Include new carrier & return roll, head & tail pulley assemblies, spring type belt cleaner.

27 **Proportioning Pump.** Unique high speed valves, pulse free flow, no packing featured on Hills-McCanna Co. proportioning pump. Bulletin tells what it is, why designed, what it will do & how it works.

28 **Nylined Bearings.** Added to line of Thomson Industries, Inc. a Nylined bearing for use where increased wear resistance is required or no lubrication is possible. Two types—for use where lubrication is requried or not.

29 **Laboratory Stirrer.** An electronic controlled laboratory stirrer with variable speed at full torque, having direct gear & gear drive in one motor described in leaflet from Ace Glass, Inc. D.C. control on a.c.; a.c. 110 v. 60 cycle, single phase motor, 1/50 hp. fully enclosed. Speed 400 to 4,000 rev./min. in stepless control.

30 **Triple Beam Balance.** Having a sensitivity of 1 cg. and capacity of 311 gr. & said to fulfill the gap between the analytical & trip balance, is the C.G. 311 Cent-O-Gram balance from Ohaus Scale Corp. Has a light duralumin beam, self-aligning agate bearings.

31 **Pneumatic Thermostat.** A non-bleed pneumatic temperature control for operation of diaphragm valves, damper motors & other control equipment from Powers Regulator Co. Temperature range 35° to 135° F. Easily adjusted dial, sensitivity adjustable from ⅛ to 2 lb./sq.in. per 1° of change. Simply designed & ruggedly constructed.

32 **Filter Cover.** Hydraulically operated & quick-opening cover is new operational & safety feature on horizontal & vertical filters made by Niagara Filters div. of American Machine and Metals, Inc. Provides effortless opening & closing of filter tank, even seating of cover. Repair & replacement of hand wheels & eye bolts completely avoided. Standard on horizontal filters.

33 **Steam Diffuser.** From O'Brien Steam Specialty Co., Inc. a V-groove steam diffuser for direct open-tank water heating said to result in 100% heating efficiency. Available in Everdur (copper silicon alloy) or 304 stainless steel, 1¼ or 2 in. diam., 12, 18 & 24 in. long. Spiral design of groove gives rapid mixing & uniform water temperature throughout tank.

34 **Fatigue Tester.** For testing loaded paperboard, fiberboard & wooden cartons & boxes L. O. Koven & Brother, Inc. have developed a fatigue tester. Automatic counting device indicates number of times carton drops from one baffle to another. Handles small-medium containers.

35 **Recorder-Controller Instruments.** Complete new line of recorder-controller instruments with wide range of industrial uses from Fielden Instrument div. Robertshaw-Fulton Controls Co. Nickel, tungsten & platinum resistance temperature detectors available, temperatures of −200° C. to +500° C. Both electric & pneumaitc controls available.

CHEMICALS

40 **Fatty Acids.** 24-page catalog "Fatty Acids in Modern Industry," compiled by A. Gross & Co. Contains specifications, grades, packing, stock points on stearic, oleic, other fatty acids. Also information on glycerine, pitch, & hydrogenated tallow fatty acids.

41 **Maleic Anhydride.** National Aniline Div., Allied Chemical & Dye Corp. at Moundsville, W. Va., now produces maleic anhydride in improved tablet form. Said to resist degradation in handling & minimizes fines. Handy, easily dissolved features appeal for process control. Folder.

42 **Expandable Polystyrene.** Foamable polystyrene, an advance in the field of expanded plastics described in brochure from Koppers Co., Inc. Covers applications including thermal insulation, electronics, & packaging. Also includes technical information with charts & diagrams in color.

43 **Fatty Acid.** A high molecular fatty acid added to line of Aceto Chemical Co., Inc. cosmetic raw materials. Said to be about 10° C. higher than melting point of stearic acid, & 90% pure.

44 **Silicone Rubber Gums.** General Electric Co.'s Silicone Products Dept. announces development of two new silicone rubber gums for manufacture of silicone rubber compounds. Double strength to any previously known. Designed for combination with new filler—fine silica technical—from Du Pont. Said to produce material of double normal tensile strength—from 200 to 300 lb./sq.in. with 50% higher elongation.

45 **Urea.** Folder from Grace Chemical Co. on urea. For compounding resins, pharmaceuticals, chemicals, fertilizers, other uses. Formula, solubility chart, other data.

46 **Anion Exchange Resins.** Called Duolite A-41 a difunctional strongly basic anion exchange resin from Chemical Process Co. Leaflet details nature & operating characteristics of this aliphatic-type anion exchanger, including all pertinent data.

47 **Synthetic Resins.** Pentaerythritol, plasticizers & synthetic resins are subject of bulletin from Hercules Powder Co. Lists applications varying from liquids to high-melting solids, including protective coatings, inks, plastics, adhesives for synthetic resins.

48 **Methyl Cellosolve Acetate & Ethylene Cyanohydrin.**
49 **(48)** Now commercially available in tank or drum carload quantities, ethylene cyanohydrin from Carbide and Carbon Chemicals Co. Substance is a highly reactive intermediate that undergoes reactions of both a primary alcohol & an aliphatic nitrile. Important in synthesis of acrylonitrile & other materials; manufacture of resins & plastics. **(49)** Technical bulletin on methyl cellosolve acetate. Gives physical properties, specifications, solvent properties. Employed for formulation of lacquers & dopes; solution of coatings of adhesives based on cellulose mixed esters.

50 **Octylphenol & Nonylphenol.** From Special Products Dept. of Rohm & Haas Co. bulletin on octylphenol & nonylphenol. Included are physical properties, uses, chemical reactions in detail, with a bibliography.

BULLETINS

55 **Centrifugal Pumps.** Complete line of Rheinhuette custom-built centrifugal pumps & valves covered in a literature packet from Neumann & Welchman, Inc.

56 **Dust Collectors.** Two designs of dual-clone dust collectors by Johnson March Corp. said to have low resistance & high cleaning efficiency illustrated in folder.

57 **Tank Venting Equipment.** Sellers Injector Corp. Burp valve is designed to withstand fluctuating seasonal temperatures, give positive parts protection with minimum vapor loss & maximum safety.

58 **Centrifugal Pumps.** New with General Ceramics Corp. LV series armored porcelain centrifugal pumps. Erosion & corrosion resistance of porcelain combined with rugged, heavy cast iron armor. Standard mechanical type seal. Illustrated leaflet shows schematic diagram, details of construction.

59 **Electric Valve Controls.** For automation & computer control electric valve operators from Techniflex Corp. Features higher stroke speed, drivers for rotary & reciprocating motion stems, protection to valve trim. Snap acting for on-off manual or automatic duty. Push-button remote for manual duty. Instrument responsive for throttling duty. Leaflet available.

60 **Spectrophotometer Recorder.** Continuous ultra-violet & visual spectra with speed accuracy, versatility provided by Spectracord recorder from Warren Electronics, Inc. Double or single beam, compatible with existing equipment, easy installation. Bulletin shows cutaway views, charts.

61 **Centrifugal Thrower Units.** Swiveloader standard & Swivelpiler a portable unit are subjects of bulletin from Stephens-Adamson Mfg. Co. Eliminate hand trimming, load largest cars faster, safer, & cheaper; also fill bins or stockpile practically any bulk materials. Construction, other details described.

62 **Water Conditioning Equipment.** Regular equipment & specialties in line of Cochrane Corp. covered in recent bulletin. Includes demineralizers, reactors, hot lime zeolite.

63 **Mix & Settle Extractor.** Complete brochure on National Research Corp. Mixer-settler Extractor. Unique features described in detail. Developed for petroleum industries now serving in the chemical, petrochemical, pharmaceutical & fine chemical industries. Unit is 20-stage, made entirely of stainless steel & Teflon. May be used in product & process research & development.

64 **PV Pipe—Fittings—Tubing.** Technical data sheets from Electro Chemical Engineering & Mfg. Co. include tables, physical properties, chemical resistance, data use, & variation for specific conditions of Arcon rigid polyvinyl chloride pipe, fittings & tubing.

65 **Wall Panels.** Insulated metal & prefab wall panels available from R. C. Mahon Co. described & illustrated in catalog. Overall U factor of all types said to equal or be better than 16 in. masonary walls. Exterior wall plates in variety of materials & for all purposes rolled in any length to 60 ft. 2 in. Fiberglas insulation between ribs of inside wall plates. Thermal properties, specifications.

66 **Electronic Precision Instruments.** Recording oscillographs, amplifiers, transducers, also custom-designed instruments & instrument systems available from Wm. Miller Instruments, Inc. discussed in illustrated folder. Adaptable to test performances from most simple to complex.

67 **Miniature Potentiometer.** Bulletin from Bourns Laboratories gives detailed information on a miniature gage pressure potentiometer. Said to be of rugged construction, compact & lightweight, with precision pressure sensitivity. Size does not jeopardize reliability or operational characteristics. Air, H_2O_2, Feron, oil, typical of gases & liquids measured.

68 **Piston Valves.** Klinger Corp. of America seatless piston valves said to withstand high pressures & temperatures subject of illustrated folder. Retain pressure tightness by fit of piston sliding through two resilient compressed valve rings. Feature perfect flow control, no seats or grinding, not affected by wire drawing.

69 **Storage Vessels.** Storage & transportation of liquefied gases in vacuum-jacketed storage vessels considered in loose-leaf bulletin from Herrick L. Johnston, Inc. Unique internal suspension system reduces heat leak, eliminates potential vacuum leaks, prevents thermal stress & strain. Inner shell stainless steel or aluminum; outer shell mild steel or aluminum, with heliarc welded seams.

70 **Compressed Asbestos.** Called Klingerit an asbestos sheet for superheated & saturated steam, discussed in folder from Klinger Corporation of America. Also for use with hydraulic pressures, compressed air & other gases, acids, alkalis, oils, solvents. Technical data, application information, given.

71 **Platinum Clad.** Uses of platinum clad a material prepared by welding together plates of platinum & base metal in thickness ratios ranging from 1 : 1 to 1 : 100 detailed in folder from Baker & Co., Inc. Thicknesses from .001 in. on wire to .005 in. & .007 in. on tubing. Principal uses are heat exchange equipment, linings for pressure vessels.

72 **Liquid Precipitator.** Control of dusts discharged from stacks of cyclones, rotary dryers, kilns, roasters, accomplished by use of multiple-action scrubbing. Johnson March include six different principles in single unit for this purpose. Illustrated folder covers operating principles, applications, constructions.

73 **Engineering Services.** Illustrated 12-page booklet describes engineering services available from Foster D. Snell, Inc. consulting chemists & engineers. Activities include research for development, process development, equipment design, plant operation.

(Continued on page 58)



SEVENTEEN COMPOSITIONS...THREE DEGREES OF POROSITY...SYMMETRICAL OR POLY-SURFACE PELLETS

Your pick of catalyst supports

All told, there are over two dozen types of supports made by CARBORUNDUM. These include: ceramically bonded Poly-surface, spheroidal, and cylindrical porous pellets . . . solid, homogeneous aluminum oxide, silicon carbide and mullite grain . . . and spheroidal mullite for use as a support or heat exchange media. These constitute *the greatest variety* of supports in this field.

Among recent developments are irregular shaped porous pellets, termed "Poly-surface." These provide improved adherence of catalyst, low pressure loss, and lowest density.

Because fluidized processes are becoming increasingly important, we have available small Poly-surface pellets that are individually porous. These absorb internally as well as externally, and expose the catalyst continuously, in spite of attrition.

Both the Poly-surface and symmetrical pellets are highly refractory and resistant to most acids. Their attrition loss is low. Porosity ranges from 20% to 60%; water absorption from 8% to 60% by weight. Bulk densities range from 30 to 92 lbs per cu ft.

A kit containing sample quantities of all our principal carriers is available. This is complete with technical literature and will be furnished free if request is made on company letterhead. (Otherwise only literature will be sent.) Please tell us if you are particularly interested in certain materials. Address: Dept. W-114, Refractories Division, The Carborundum Company, Perth Amboy, N. J.



CARBORUNDUM

Registered Trade Mark

BULLETINS

(Continued from page 56)

74 Processing Machine. An effective dryer, cooler or dryer-cooler by Link-Belt Co. covered in new booklet. Said to successfully process hundreds of products including food, chemical & hard to process materials like sand & sugar. Called Roto-Louvre machine is a revolving, horizontal drum. Section devoted to principles of drying & cooling. Others cover temperature, dust control, dimensions, charts.

75 Diaphragm Valves. Acid, solvent, alkali-proof Permanite diaphragm valves from Maurice A. Knight described in bulletin. Permanite is a thermosetting furfuryl alcohol resin capable of fabrication into many types of corrosive handling equipment. Handles most acids, requires little maintenance, easily handled & installed.

76 Centrifugal Pump Fundamentals. Ingersoll-Rand announces availability of booklet on "Centrifugal Pump Fundamentals." Useful to pump operators & maintenance men. Explains principles of operation, defines terms used in pump calculations & works out typical pump problems.

77 Mechanical Recorders. Bulletin which describes & illustrates Bristol Co.'s electrical & mechanical recorders for round- & strip-chart models. Uses include batch weighin on platform scale, automatic weighing machines, valve or gate operation, liquid level variation.

78 Valves. High Pressure Equipment Co. leaflet covers signal system, calibrated controls & midget valves. Distinctive feature is colored handles for valves enabling engineers & research men to distinguish easily on large installations. Twelve colors standard, others available. Tubing sizes down to 1/16 in.; pressures to 30,000 lb./sq.in.

79 Compressed Gases. From Matheson Co., Inc. bulletin on compressed gases & gas regulators. Includes new compound silicon tetrafluoride & an extra dry grade of hydrogen. Also gas mixtures used in Geiger counter & proportional flow units.

80 Filtration. Clarification of water by filtration is the subject of a technical service bulletin from Dicalite div., Great Lakes Carbon Corp. Comprehensive study of the subject including equipment layouts, schematic flow sheets.

81 Engineering Services. Condenser Service & Engineering Co., Inc. in affiliation with others, designs, engineers, builds & erects a variety of equipment illustrated in their bulletin. Folder illustrates manufactured products plus maintenance services.

82 Temperature & Moisture Control. Binder insert bulletin from Niagara Blower Co. considers precise control of air temperature & moisture enabling production in any climate at any season. Recommended for conditioning of textile fibers, yarns, plastics, synthetics, & many other materials.

83 Vacuum Furnaces. Addition of 30 metals to industrial spectrum has increased use of vacuum furnaces. Bulletin from F. J. Stokes Machine Co. discusses applications in melting & casting these new materials as well as sintering, annealing, hardening, brazing, & de-gassing. Also considers field of vacuum metallurgy. Descriptions, drawings of several types included.

84 Pneumatic Conveying System. Bulletin describes & illustrates actual installation handling 350 mesh material with no dust loss or need for filter type collectors or wet scrubbers. Self-cleaning & dust tight on free flowing materials. Young Machinery Co.

85 Manual & Solenoid Valves. Catalog from Barksdale Valves contains sections on manual, solenoid, & pilot controlled valves, plus pressure switches. Patented Shear-Seal principle employed consists of pressure balanced, self-aligning, tubular valve seat with Shear-Seal in constant contact with optically flat porting disc or rotor containing flow passages. Cutaway views, characteristics, flow patterns included.

86 Infrared Spectrometer. Operating features of Perkin-Elmer Corp. single beam, double pass, recording infrared spectrometer given in folder illustrated with photographs & infrared spectra. Covers range from 2100 Å in ultraviolet to 35 microns in far infrared. Assistance in applications to specific problems, trial use & field instruction available.

87 Pneumatic Controllers. Stack-type pneumatic controllers for process variables illustrated in Fischer & Porter Co. catalog. Cutaway construction photos, schematic diagrams & dimension drawings included. Controller selection guide. For use in flow rate, liquid level, viscosity, vacuum problems.

88 Molybdenum Products. Bulletin from Climax Molybdenum Co. covers molybdenum products for chemical process industries. Applications include catalysts, fertilizers, pigments & dyes, lubricants. Describes briefly available products, their manufacture & use.

89 Plug Valve Actuator. Pantex Mfg. Corp. two-color bulletin describes plug valve actuators. Available for remote control on all types & sizes of wrench-operated plug valves from 1 in. to 8 in. Installations, line drawings, plus complete engineering data & use information.

90 Relief Valves. Single spring construction, accurate valve seating & lower overall height feature spring loaded relief valves from Schutte and Koerting Co. Single spring construction eliminates cumbersome, unstable superstructures of conventional valves. Two modifications of basic design also available.

91 Frangible discs. Series of loose-leaf catalog sheets cover variety of uses offered in protection of pressure systems by frangible discs. Disc is an individually-designed pressure relieving device for protection of equipment or process systems where over-pressure is a problem. Sheets approximate a handbook on pressure system protection. Frangible Discs, Inc.

92 Industrial Pumps. Included in 108-page illustrated catalog from Deming Co. all types of industrial pumps. Details on each type include construction, features, performance & selection tables, etc.

93 Miniature Recorder. From Minneapolis-Honeywell Regulator Co. bulletin on Tel-O-Set miniature recorder & controller. Instruments described & their operation, plus specifications. Features—face dimensions 5 25/32 in. high by 5 in. wide; automatic chart reroll gives 30-day process record.

94 Welded Fittings. Bonney Forge & Tool Works Weldolets & Thredlets are 90° branch pipe welded fittings. Applications mainly in gas, oil, power, process, heating fields; also in general plant construction & maintenance. Booklet contains illustrations & descriptions of each item, temperature & pressure ratings, material specifications & much other pertinent information.

95 Flow Tubes. Binder insert from Foster Engineering Co. describes the Gentile flow tube for measurement, regulation, control of fluid flow. Three types. Operational theory, accuracy, maintenance, other features discussed. Cutaway view plus flow sheets.

USE COOPER ALLOY PRODUCTS AND *Relax!*

A quiet day in the country, a golf game at the club, or an afternoon at the ball park—can all be yours if you learn to leave plant problems where they belong. You're on the right road to peace of mind when you specify Cooper Alloy stainless steel products—custom castings, jet engine rings, valves, fittings, accessories. Our complete control of every step in the processing from design to machining is your assurance of quality. Cooper Alloy know-how means products you can trust—use them with confidence and relax.


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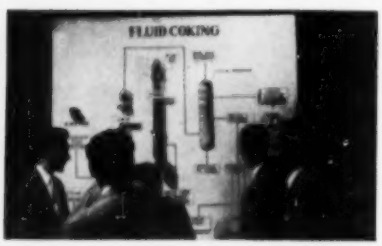
"Stainless Steel Products—custom castings, jet engine rings, valves, fittings, accessories."

New York, N. Y. October 13, 1954. —West from the Colorado Rockies, north from the great lakes of Canada, and south from the bayous of Louisiana came chemical engineers to attend this annual event held in the great chemical engineering design and decision center of the world. Sponsored by the New York section of A.I.Ch.E., the meeting featured cost estimation and new processes. Over 400 attended from 16 states, and represented management, production, development and other categories of occupation.



one-day meeting report—New York Section







SCIENTIFIC BASIS EMPLOYED IN PLANNING PROGRAM

Prior to deciding the program content B. H. Rosen (Chairman) and the other chemical engineers planning the meeting sent out to all section members (500), a questionnaire listing six possible subjects, and asking for a choice of two. 75% replied, indicating a preponderance of interest in the two subjects ultimately chosen for the program. This action probably accounted for not only the sizeable turnout, but also for the quality, considering the number of chemical engineers of high responsibility seen at the sessions.

Knowing what plant costs will be

One of the greatest responsibilities of the chemical engineer in management is to know what new facilities will cost to build, maintain and operate. To do this, several established procedures are followed, with the amount of time and effort required being almost directly proportional to the accuracy demanded. Of these, the final step is usually to obtain, add, and review competitive bids for all equipment, services and facilities. Long before this step is taken, however, it is necessary to *approximately* estimate the amount of funds to be required, in order to provide the basis for decision as to prospect for returns from products marketed, and more than likely also to serve as a basis for setting up arrangements for financing the project.

It is in this area—of preliminary estimating costs—that efforts are being directed towards evolving a method which will, with a fair degree of accuracy and modest expenditure of effort, provide practical and dependable results.

The papers presented at the cost estimation symposium, organized by Roger Willliams, Jr., are believed to contribute to an important degree to the advancement of this objective—bringing together the experience of many firms, for the benefit of the individual. The papers are reviewed briefly as follows:

Estimating maintenance costs for new plants

Maintenance costs in a chemical process plant may run from a few per cent to as high as 20% of the total manufacturing costs; R. L. Glauz (Diamond Alkali Co.) reported relationships he has developed between repair man hours and plant investment to improve preliminary estimates of repair costs when considering new plants.

(*Continued on page 68*)

New process developments

New developments in chemical processes were covered in two symposia: chemical processing and petroleum processing. The first of these tended to summarize marketing results experienced to date in the three broad fields covered. The second, on petroleum processes, covered specific processes or processing steps available to the refiner for achieving improved technical and economic results. The papers presented in these symposia organized by L. J. Coulthurst and A. H. Tenney are reviewed as follows:

New developments in textile fibers

The market for synthetic fibers is already large, and growing rapidly, providing one of the largest outlets for the products of the organic chemical industry, according to C. A. Setterstrom and G. H. Freeman (Carbide & Carbon Chemicals Co.). In contrast to a depressed market condition, synthetic fiber developments have been going along at a high rate, some of which are as follows: The incorporation of dyes in the "dope" before extrusion into filaments, the production of uneven strains in filaments to induce curling, partial-saponification of acetate fibers to improve strength, extension of U. S. nylon capacity to an expected 280 million lb./yr. within months, and preparation of a Teflon yarn. The future in this field holds exciting promise, as every one of the large chemical companies and many smaller ones, are reported by Mr. Freeman as maintaining major programs aimed at the development of new fibers. To fully test a new fiber commercially, Mr. Freeman estimates the cost to be between 40 and 75 million dollars, and believes that the aforementioned firms

(*Continued from page 74*)



DRYING PROBLEMS?

JUST WRAP 'EM UP AND SEND 'EM TO US . .

STRAIGHT ACROSS THE BOARD FROM ABRASIVES TO YARNS

HERE ARE A FEW OF THE PRODUCTS WE'VE TESTED IN OUR LABORATORY FOR MORE EFFICIENT DRYING

Abrasives
Apples
Asbestos
Bast Fibres
Beans
Bristles
Building Materials
Calcium Carbonate
Chemicals
Clay Fillers for paper
Cloth
Coatings
Coconut
Cotton
Dehydrated Foods
Explosives
Fertilizers
Flock
Flour
Fruits
Grain (cooling)
Hides
Hair
Kaolin
Latex
Macaroni
Metal Parts and Products
Nuts
Paints
Paper & Paper Products
Peanuts
Peat Moss
Pigments
Plastics raw stock
Printing Inks
Proteins
Pulp
Rice
Rubber—reclaimed, synthetic and natural
Salt
Sawdust
Sisal
Synthetic Fibres
Textiles—raw and dyed stock
Tobacco
Waste Sludges
Wool
Yarns

CAN YOU ANSWER THESE QUESTIONS ABOUT THE DRYING OF YOUR PRODUCT?

1. Is it dried uniformly, to exact degree desired — under complete control at every stage?
2. Are you getting maximum rate of production possible, yet maintaining automatically controlled, unvarying quality?
3. Is your drying process the most efficient possible — quality-wise, AND cost-wise? No steam or hot dry air waste? Using minimum floor area? And optimum bed depth? Would alternate airflow direction zones help, or radiant heat boosters, or varying temperature zones?
4. Is your product correctly pre-conditioned for most efficient drying? Have you ever compared drying curves to be certain that every important variable is controlled within pre-set limits — automatically?
5. Which type of dryer is best for your product — tunnel, pole, tray, truck, or special design?

SARGENT can give you the answers to these and many other questions. For better, less costly, more efficient operation of drying processes, write us.



May We Help You . . .

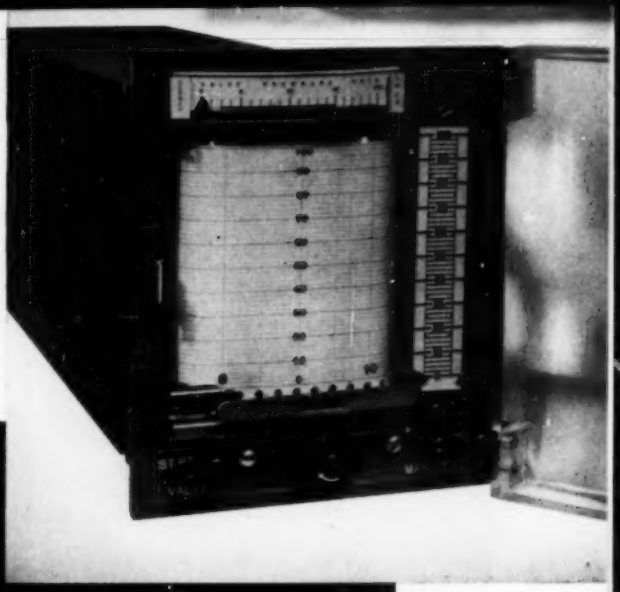
determine the one best commercially practical way to dry YOUR product easier, quicker, more economically? Just write us.

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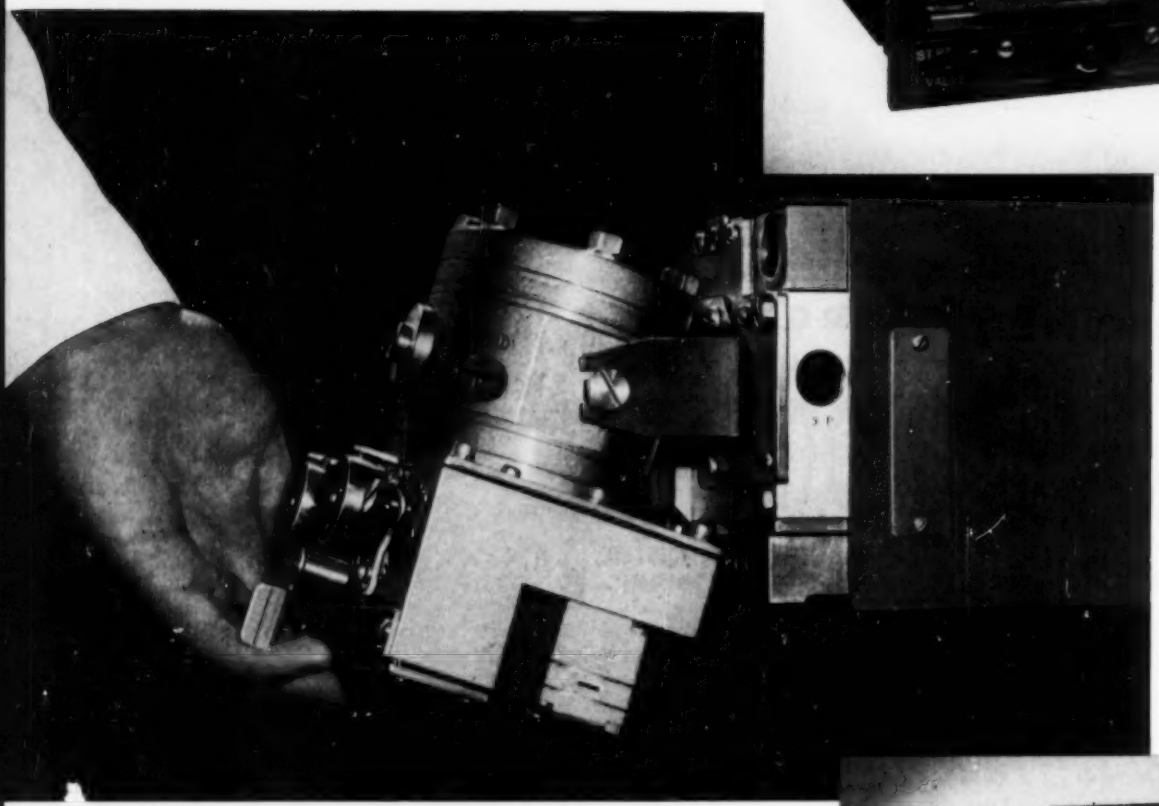
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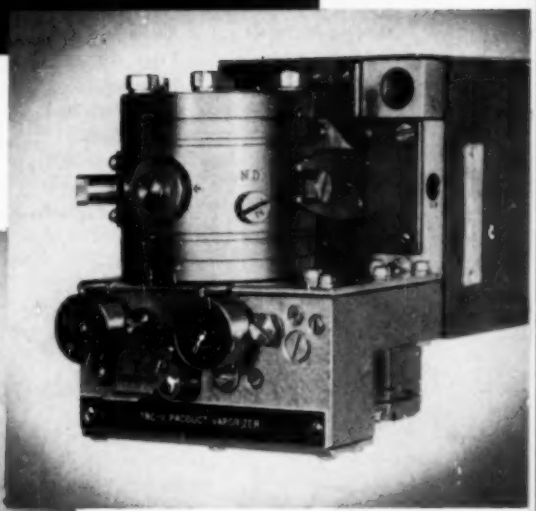
Horizontal scale above chart provides continuous indication of control air pressure to valve.

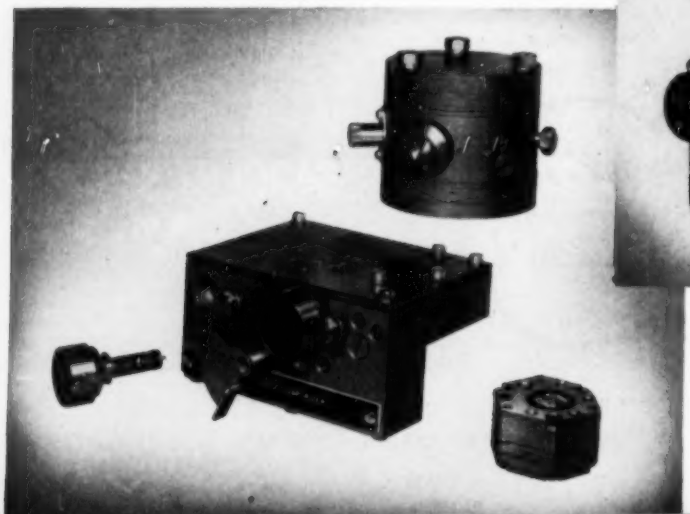


Quick-connect controller mounting . . . for added protection the controller is supported by a yoke when disconnected.



All adjustments are readily accessible from the rear of the controller.





Unitized construction of all major components simplifies maintenance . . . makes reassembly foolproof.

Today's Tel-O-Set* instruments are easiest to install . . . operate . . . service

THE latest improvements in the *Tel-O-Set* family of miniature recorders and controllers make them the simplest and most convenient ever. Operating men, installers and service men alike will appreciate these outstanding features:

Quick-connect mounting—either on back of recorder, back of panel, or at a remote location. A single lever opens or closes all interconnecting air lines . . . allows the controller to be removed without interfering with manual control of the process.

Foolproof connect and disconnect. The rear of the recorder is a flat gasketed surface that matches up perfectly with the controller. It's completely free of any protruding valve stems or plug-in fittings that might be damaged in shipping or handling in your plant. Self-contained air switch must be shut off before the controller can be removed.

Leakproof design—with large capacity valves.

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Versatility. Rate action is readily added. When equipped with a manifold, the controller can be mounted remotely, either back of the panel or in the field.

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Compare the features . . . and the operating characteristics . . . of the *Tel-O-Set* line of instruments. You'll find they represent the top in value in miniature instrumentation, that will give you the top in performance and serviceability on your process control panels. For a discussion of your specific requirements, call your nearby Honeywell sales engineer . . . he's as near to you as your phone.

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● **REFERENCE DATA:** Write for your copy of new Bulletin No. 7201, "Quick-Connect *Tel-O-Set* Instruments."

**Tel-O-Set* is a trade mark of the Minneapolis-Honeywell Regulator Co.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

South Texas 9th annual 1 day meeting

and industrial exposition





Top, W. D. Seyfried
bottom, Henry Groppe

The Ninth Annual Technical Session of the South Texas Section attended by 525 members and visitors provided not only lively symposia but also an exposition displaying the equipment and materials of 29 companies supplying the chemical process industries. The meeting and exposition were held on Oct. 22 in the Galvez Hotel, Galveston, Texas. Close to 400 attended the annual award banquet. The annual award of the South Texas Section given for the "best paper published by a member of the South Texas Section in 1953" was presented to M. Van Winkle, U. of Texas Chemical Engineering Staff. Dr. Van Winkle's paper, based on work done by himself and K. T. Okamoto, was titled "Equilibrium Flash Vaporization of Petroleum Fractions." Papers are abstracted, as follows:

GENERAL PETRO-CHEMICAL OUTLOOK FOR THE GULF COAST

Over 25% of the chemicals produced in this country are derived from petroleum and natural gas, and within the next 10 years this share may be increased to 50%, according to H. Groppe, Monsanto. The rapid growth of the petrochemical industry in the Gulf Coast area to the point that about 75% of the country's production is located there is primarily influenced by the abundance of the relatively cheap raw materials and fuel in the form of petroleum and natural gas hydrocarbons. The advantage of low fuel costs, as one of the area's assets, is however, losing its place in influencing the growth potential due to recent increases in costs of fuel. Such increase in price of natural gas is also being reflected in the prices of ethane and other hydrocarbon raw materials recovered from this source.

There are few of the thousands of chemicals produced by the industry that cannot be made from alternate raw materials. In the case of the hydrocarbon chemicals there is constant competition between natural products, coal and petroleum raw materials. Important raw material supply developments include the trend towards location of petrochemical plants near ultimate consumer markets, and the increasing importation of foreign crude oil. On the East Coast, for example, there has been a 96% increase in petroleum refining runs in the past decade. Increased future attention will undoubtedly focus on location of supplying plants close by such refining centers. Transporation costs have always been a major problem for Gulf Coast producers since the major consumer product markets are in the northeast. The cost of transporting raw materials must be continuously compared with the cost of transporting the finished product. The growth of the long distance gas transmission industry has a deleterious effect on the Gulf Coast. This affords the opportunity for large scale processing for recovery of ethane and heavier hydrocarbons remaining in the gas at or near the market end of the pipeline, which can be transported in their raw material condition rather cheaply. Another is the transportation of propane and butane as LPG in crude product pipeline systems which would allow lower cost raw materials for petrochemicals production near consumer centers.

It appears that new plant location in the Gulf Coast region will be given close consideration in the future.

PLANT SITE SELECTION

A scientific approach to the selection of a plant site involving six steps was presented by S. P. Smith, Carbide and Carbon Chemicals Corporation. His procedure comprises in general, the weighing of requirements for the new plant against characteristics of various site possibilities. The economic basis for this evaluation is found in the estimates of raw materials, utilities, labor, and sales outlets required for the new plant. Although factors other than economic are not considered, business policy such as matters pertaining to competition, distribution finances, trade trends and pricing may exert a strong influence.

The first of the six steps calls for considering the influence of four primary factors. Raw materials, consumers, fuel and power, and climate. This permits elimination of other regions as the second step. The third step considers the influence of the secondary factors of water supply, waste disposal, transportation facilities, taxes, regulatory laws, labor, proximity of other industries, general surroundings, site characteristics, and living conditions. The eliciting of outside aid is the fourth step. Railroads, and utility companies and public organizations, maintain an inventory of all attractive industrial sites within the territory they serve. By communicating with them, data as to availability and quality can be obtained. The fifth step is the appraisal of these sites from the information supplied by the promoter or that obtained by brief inspection. In this appraisal, detailed attention is directed to the general surroundings, proximity to other industries and site characteristics. The availability of labor and rates are scrutinized. Much useful information on this can be obtained from the State Department of Labor of locations under consideration. Each of the sites surviving step five are re-examined critically as the sixth and final step.

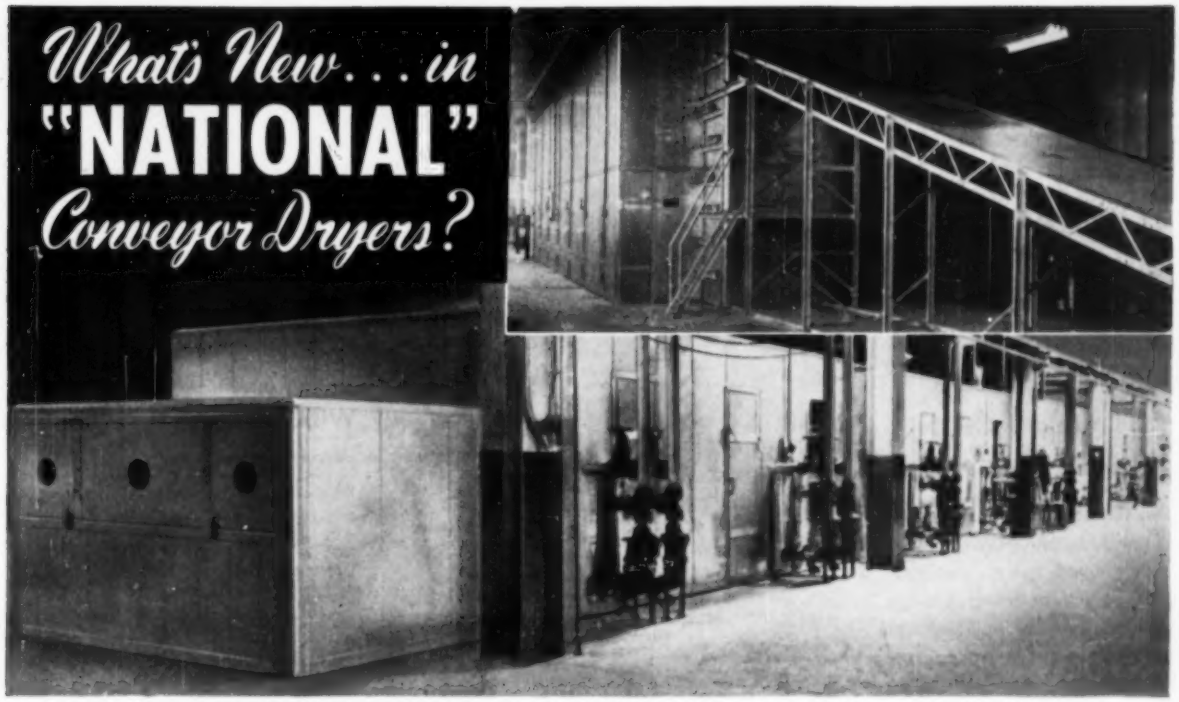
TRENDS IN OXYCHEMICALS

The minimum economical size of oxychemical plant has a production capacity of 150 million pounds per year, according to J. E. Wall, Celanese Corp. Even a larger plant is preferred for the production of these chemicals since the majority of products sell for less than $0.10/lb., large volumes at low cost must be produced. As an example of the complexity of the process employed at Bishop, Texas, about 80 columns (fractionators, absorbers, strippers, extractros) are required for this complicated recovery of oxygenated hydrocarbons from the direct oxidation of propane and butane.

There is a market expansion going on for oxychemicals and this will raise requirements above existing production capacities. Moreover, technological advances are making some existing units obsolete. Celanese was described as acquiring additional production capacity by the revision and expansion of existing plants.

(Continued on page 76)

What's New . . . in "NATIONAL" *Conveyor Dryers?*



Two "National" Conveyor Dryers are illustrated above: Upper, a large Multiple-Unit, Multiple Apron dryer; lower, a fourteen-section Multiple-Unit, Single Apron Machine.

NEW "P-4" CONSTRUCTION

"P-4" Construction means a precision-built, pre-fabricated, truss-type structure, providing a new measure of strength, rigidity and durability. Advantages to the customer are obvious: Longer service life for the Dryer; smoother operation; freer access for cleaning and maintenance; and reduction of installation time in the customer's plant of as much as 50%. Another important feature of "P-4" Truss Type Construction is that the special method of attaching the panels meets all Underwriter's Codes covering explosion hazards.

IMPROVED HOUSING PANELS

The new insulated panels (Patented and Patents Pending) used for the housing are larger, stronger, more rigid, and, with their 4" insulation, provide greater protection against heat loss. They are of trussed-and-tensioned, non-through-metal construction and incorporate expansion-contraction compensation.

IMPROVED AIR DISTRIBUTION AND CONTROL

The exceptionally high drying speed of "NATIONAL" Dryers results from a combination of adjustable fan power and a unique air distribution system, controlled to assure equal volume of air to the entire run. There is no "shading"—no uneven drying. This arrangement permits drying at consistently higher speeds than those previously permissible. Patented Indexing Orifices, Turning Vanes and other devices and arrangements assure unequalled versatility and precision in air distribution and control.

SUPER-POWER FANS

"NATIONAL" has developed the adjustable-pitch principle into its axial-flow fans which provides far greater operating potentials than heretofore used in any drying machinery. Greater speeds and volume of air can now be employed and adjusted to the specific requirements of the drying operation. The new fan construction includes special alloyed metals fabricated by an improved welding technique. The Fan mountings, insulation and lubricating systems have also been redesigned to provide improved smoothness of operation and virtually no maintenance.

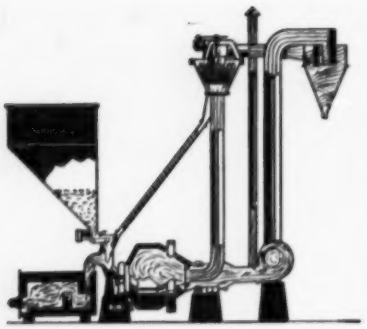
• • •

Other features of "NATIONAL" Conveyor Dryers include continuous hopper feeds; automatic leveler to conveyor belt; pressure extraction and heating for pre-drying.

Write for Complete Information

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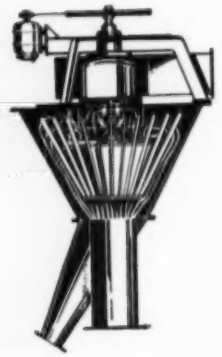
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It DRIES
while it GRINDS
while it CLASSIFIES

The Hardinge "Thermomill" is an ingenious combination of Conical Mill, air classification system and air preheater. It dries, grinds and classifies—in a single system—materials carrying an appreciable amount of surface moisture, reducing them to dry, fine-ground products. Write for Bulletin 17-B-40.

The new
"GYROTOR"
is a key item in the
"Thermomill"



The new Hardinge "Gyrotor" Air Classifier is a separator designed for extremely close control of product. It has a wide range of fineness, controlled by simply changing the rotor speed. Overall classifier efficiency is higher than any attained by similar devices heretofore. Bulletin AH-449-40.

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H. P. Grace



J. A. Quinn



J. W. Klar

1954 AWARD WINNERS

Two of the institute awards to be presented at the Annual Awards Banquet on Dec. 14 in the Hotel Statler, New York, during the annual meeting have been announced by the Awards Committee. Chalmer G. Kirkbride, president of the Institute, will present the Junior Member Award to H. P. Grace of Du Pont, and the A. McLaren White Award to J. A. Quinn, who is a graduate student at Princeton.

Junior Membership Award

The Awards Committee, headed by Professor R. H. Wilhelm, Princeton University, in selecting the recipient for the award for "the paper judged most outstanding of those published by Junior members of the Institute during the last three years" cited Mr. Grace for his two papers "What Type Filter and Why," and "Resistance and Compressibility of Filter Cakes." Mr. Grace, a native of Kansas, received his B.S. in Chemical Engineering from the University of Pennsylvania in 1941. Following graduation he was employed in the engineering department of Du Pont as a field engineer. After a tour of duty in the Navy as an airborne electronics officer he returned to Du Pont as a research project engineer in 1952.

A. McLaren White Award

The over-all economics concerning the desirability of replacing a thermal reforming process with a catalytic reforming process was the subject of this year's problem to be solved by candidates for the A. McLaren Award. This award given annually in memory of a young chemical engineer was won this year by J. A. Quinn, a graduate student in chemical engineering at Princeton University. Mr. Quinn, who graduated in 1945 with highest honors from the University of Illinois, will receive the prize amounting to $200.

The second prize winner of $100 is J. W. Klar, a native of New York State, and a recent graduate from Purdue University. He is presently employed as a graduate research assistant in the Purdue Graduate School.

Third prize of $50 goes to R. B. Grady, a 1954 graduate of the University of Minnesota who is engaged in petroleum technical service for Esso Standard Oil Co., Baton Rouge, La.

Honorable mention went to F. H. Helm, University of California; E. Borsuk, University of Illinois; J. L. Hanchette, Clarkson College of Technology.

BELGIUM GETS HOUDRIFLOW CAT-CRACKER

The demand for high quality gasoline caused by the influx of American cars in Belgium has prompted the construction of a 36,000 bbl./stream-day Houdriflow Catalytic Cracking unit in Antwerp, Belgium for the refinery of Albatros S.A. Belge pour le Raffinage de Petrole. The new unit is one of a major expansion program of the plant for the polymerization of light olefins and the treatment of straight run and catalytic gasolines. In the cracker bead catalyst is circulated at the rate of 110 tons/hour with an average cracking temperature of 880° F. It has a coke burning design capacity of 200 lb./hr.

BY-PRODUCT H_2 FOR AMMONIA SYNTHESIS

Up to 23 million cu. ft./day of by-product hydrogen from the refineries of Sinclair in East Chicago and Standard Oil in Hammond, Ind., will feed a new 300 ton/day anhydrous ammonia plant to be constructed in Hammond under the supervision of Standard Oil. The plant will be the largest in the country for producing anhydrous ammonia using by-product hydrogen and will be operated by Standard Oil under contract with a new company to be formed.

Hydrogen piped into the new plant will be separated from the other gases in a low-temperature fractionating unit. Nitrogen will also be fractionated.

STAFFED TO HANDLE MAJOR PROJECTS



WORKING WITH our process engineers on all projects, both plant and unit design, are staff engineers well versed in specialized phases of engineering such as electrical, mechanical, steam, power, hydraulic and structural.

Perhaps our service will be just what you are looking for—a service responsible for the design and construction of your complete plant or unit project. What you are looking for in size... integrated experiences... flexibility... and broad knowledge of processing!

Photograph shows recently completed naphthalene unit

EXPERIENCED IN THE FOLLOWING:

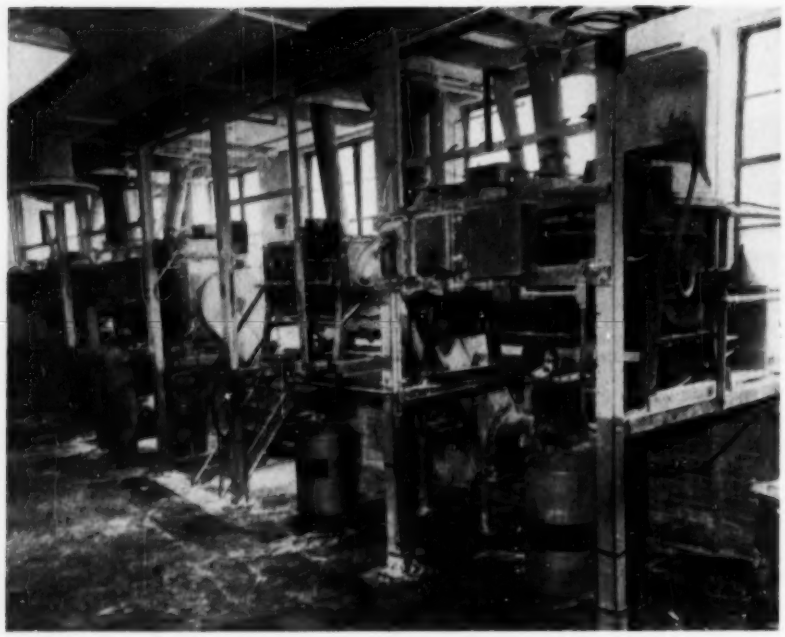
- Organic Chemical Synthesis
- Inorganic Chemical Processing
- Catalytic Operations
- Solvent purification
- Separation and Refining of Organic Chemical Mixtures by conventional, azeotropic and extractive distillation, liquid-liquid extraction, crystallization
- Petroleum Processing: Topping and Vacuum Distillation Lube Oil Units
- Coal Tar Distillation
- Gas and Vapor Recovery
- Pharmaceuticals

Engineering

- Design and Construction of Process Plants
- Design and Construction of Process Units
- Process Evaluations
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14 YEARS of CONTINUOUS 24-HOUR-A-DAY-SERVICE

A leading manufacturer of a special plastic material mix the entire production of their plant in 4 Paul O. Abbe Mixers.

"Noteworthy features of this equipment," the user reports, "which was installed in 1941, is that we use these mixers at their maximum capacity continuously, 24 hours a day, and they must be capable of mixing a wide variety of formulations homogeneously.

"They are readily cleaned—cleanliness is important. They are ideal for our process.

"Another advantage to us is that we find maintenance costs are low."

PAUL O. ABBE INC.

271 Center Avenue Little Falls, New Jersey

N. Y. ONE-DAY MEETING

(*Continued from page 60*)

Depreciation and amortization

In estimating the operating cost of a plant for manufacturing a new chemical, it may be found that depreciation will be a more important item than operating labor. A. Lawrence (E. I. du Pont de Nemours), a chemical engineer working in the field of accounting, explained the necessity of a chemical engineer in management developing an understanding of amortization and depreciation, and how they affect his operations. The investment required per worker in the chemical industries is higher than in most other industries and is increasing with the rising trend towards use of automatic controls. Because of rapid technological advances in the chemical process industries the obsolescence of process, product, capacity or sales are high factors in the financial considerations of plants.

The newly revised tax law, generally speaking, is regarded as encouraging to new investment since it permits faster recovery of capital by depreciation, according to Mr. Lawrence. In addition, it puts the burden of proof on the government rather than on the taxpayer as in the previous law, and permits the taxpayer to select the method for calculating depreciation.

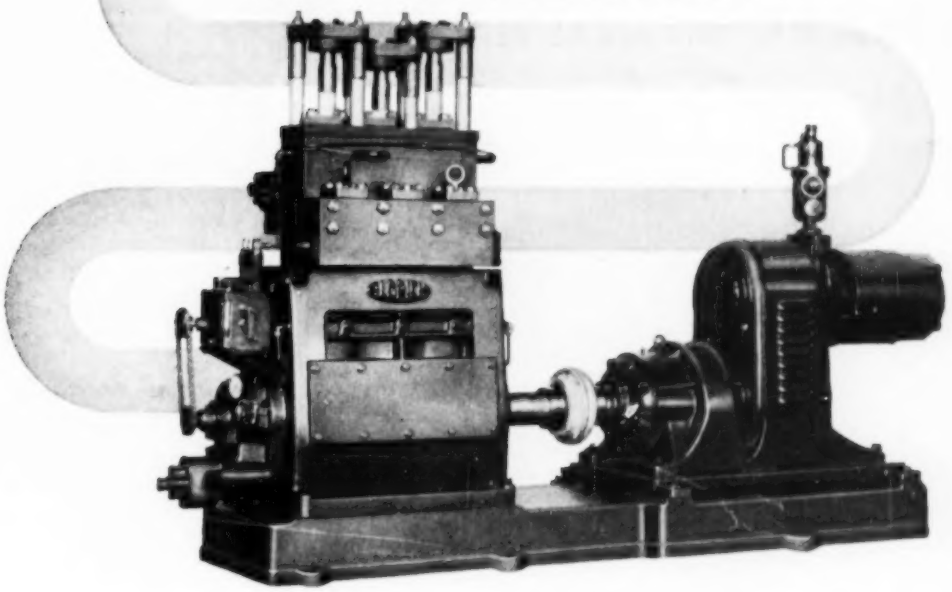
Comparison of chemical and petroleum accounting in analysis of new plant economics

Competitive production of the same chemicals by both the petroleum and chemical industries often necessitates an increased awareness of the basic differences in economic evaluation methods when estimating on new projects. This is especially true in those cases where the chemical industry depends on the petroleum industry for raw chemical materials. R. A. Wiegard (Sinclair Chemicals) pointed out that this has prompted the establishment of chemical divisions as subsidiaries of oil companies. A relatively recent emergence of the "joint venture" between oil and chemical companies is an outcome of this situation. These companies pool raw materials, capital and "know how" to obtain vertical integration with minimum risk to both parties. Mr. Wiegard has initiated surveys of practices of various chemical and petroleum companies to determine the similarities and differences between chemical and petroleum accounting in new plant evaluation as applied to a typical petrochemical project, and reported on this in his paper.

(*Continued on page 70*)

for your special pumping needs . . .

specify ALDRICH!



Here's an Aldrich Triplex specifically made to pump very highly abrasive slurry that would make short work of most pumps. A typical special Aldrich design, it features solid porcelain plungers—Kennametal ball valves and seats—an oversized oil pump for slow operation. Variable drive is provided by a U. S. Varidrive motor operated by Varitrol automatic control.

Aldrich Pumps are ideal for applications involving corrosion, high viscosity, high pressure, or abrasive materials . . . and the complete range of sizes insures a proper Aldrich pump for every need. Ask for recommendations to meet *your* chemical pumping needs.

the ALDRICH *pump company*

. . . Originators of the Direct Flow Pump

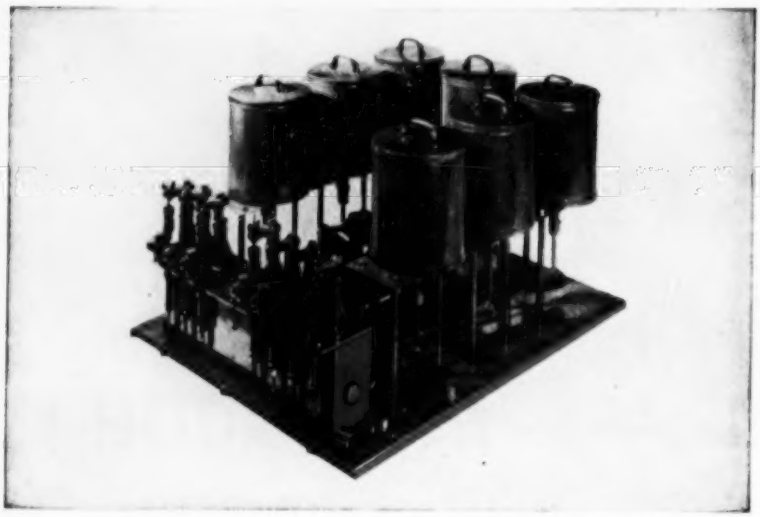
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* In chemical processes where foaming is a problem, Manzel engineers have a record of successfully eliminating it through the use of Manzel Chemical Feeders. There are models of large and small capacity—for simultaneously feeding many different chemicals at rates from a few drops to 60 gph per feed. They are easily synchronized with any process — supremely accurate and dependable in service.

Specialists, too, in Force Feed Lubrication

Manzel Force Feed Lubricators can be depended upon to deliver exactly the right amount of lubricant, to exactly the right places, at exactly the right times. Available for operation against discharge pressures of up to 30,000 P. S. I. G.

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352 BABCOCK STREET, BUFFALO 10, NEW YORK

N. Y. ONE-DAY MEETING

(*Continued from page 68*)

Cost of low temperature processing

Estimation of costs and methods involved in low temperature processing can be more easily and accurately performed by taking benefit of the data and experience accumulated in the design and operation of low temperature air separation plants, according to B. H. Van Dyke and W. J. Dougherty (Air Products, Inc.). Mr. Van Dyke described what low temperature processing entails, where it can be applied, and the variables that affect the selection of a process cycle and their effects upon costs. The size of operation was said to materially determine the choice of gaseous separation with the economic favor of the freeze-out method being greatest with the large installations. In some instances, the lowest unit net cost system will involve the highest initial capital investment. The availability of money at the time the plant is to be built, rather than engineering, might therefore, dictate the choice of process.

Costs of chemical plant auxiliaries

If you're contemplating chemical plant construction a few pieces of choice information for estimating costs from H. C. Baumann (Chemical Const. Corp.) are of interest. Scrutiny of a tabulation of costs involved in 50 chemical plants shows that from 10% to as much as 40% of the costs of the plant are attributable to structures, equipment and services which are auxiliaries in that they don't enter directly into the chemical process. Of these plant auxiliaries steam and water generation and distribution consume from ½ to ⅔ of these costs. Auxiliary buildings such as office, storage and medical are the greatest expense and show the widest variation in cost as are demonstrated by the modern structures of pharmaceutical plants as contrasted to the ammonia plant which is expected to have a minimum practical type of office structure. A figure of 20% for auxiliaries is associated with a single product plant employing less than 50 whereas a large multi process "grass roots" type of plant is near the 40% figure. Familiar costs are $3 to $8/lb. for steam generation, $150 to $300/kw. of electricity generated, $23/sq.ft. for personnel office building, $17.50/sq.ft. for administration building, and shop buildings at $12.50/sq.ft.

Some considerations in pressure vessel design

The war of the estimates between

(*Continued on page 72*)

Internal **TRAFFIC CONTROL** in your **PROCESS VESSELS** with **YORKMESH DeMISTERS**



There's a green light for vapor and a stop for entrained liquid when Yorkmesh Demisters are on the job providing internal traffic control in your process vessels. Designed and constructed to effect clean separation between liquid and vapor, even at velocities which may be considered excessive, Yorkmesh Demisters improve the performance and increase the throughput capacity of vacuum towers, distillation equipment, scrubbers, gas absorbers, knock-out drums and other process vessels handling both liquid and vapor phase materials.

Easily installed in new or existing equipment these specially knitted fine wire mesh demisters provide highest efficiency at lowest cost, and are available in a wide range of corrosion resistant materials. To find out how Yorkmesh Demisters can improve the performance of your process vessels, write for Bulletin 16.

YORK

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above left: sectional construction
above right: one piece construction

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COMPACT FIRED HEAT EXCHANGERS CAN SOLVE YOUR HEAT TRANSFER PROBLEM . . .



PRESSURE: 300 PSIG

TEMPERATURE: 1200 F

CAPACITIES: 750,000 TO 8,000,000 BTU/HR

TYPE DF for high pressure, high temperature applications.



PRESSURE: 50 PSIG

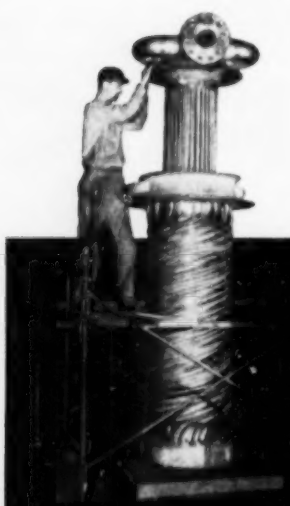
TEMPERATURE: 1000 F

CAPACITIES: 250,000 TO 1,500,000 BTU/HR

TYPE FT for medium pressure and temperature applications.

Unique THERMAL Burners make these heat exchangers possible—

Whether it be an existing standard design or a unit for your special requirements, THERMAL heat exchangers provide the ultimate in compactness, high performance and response. Always designed around the high velocity combustion characteristics of THERMAL burners, they are supplied as complete "package" installations including all control and accessory equipment.



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Both the type DF and FT THERMAL Heat Exchangers use a coiled tube design feature to allow for expansion. The clear flame characteristic of the THERMAL Burner makes convection the primary heat transfer means and thus promotes uniform metal temperature and long life.

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REPRESENTATIVES IN PRINCIPAL CITIES

N. Y. ONE-DAY MEETING

(Continued from page 70)

competing bidders is rapidly gaining momentum according to V. Weiler (A. O. Smith Corp.). With the development of highly competitive markets, general contractors for refinery, chemical and petrochemical plants are requiring formal bids from equipment manufacturers before submitting proposals on a major project. In the last six months almost every general contractor has shifted the responsibility of establishment of major equipment costs from their own estimators to their purchasing departments, which in turn make heavy estimating demands upon the equipment manufacturers. Mr. Weiler said that approximately 80% of his own company's estimating capacity is being used up by engineering contractors with as many as fifteen different firms asking for confirmed pricing for the same project, all with designs varying enough to require multifold estimating effort.

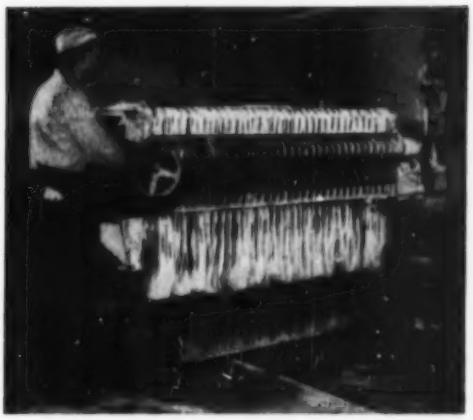
In many cases bidding has shown unexplainable erratic tendencies often appearing to have no relationship to the cost of manufacture. It is felt by Mr. Weiler that such fluctuations need not exist. Athough an estimate may vary as much as 10% throughout the year due to fluctuating material and labor prices, an accuracy of 2% is readily achieved if proper consideration is given to many variable conditions. Although the final cost of pressure vessels constructed from various materials is usually relative to the basic material costs the demand of high temperature, high pressures and corrosive conditions will alter the material of greatest economy, as the scale of temperature pressure and corrosion is traversed. In high pressure vessels, factors of safety and design formulae for determining material thickness become influential in determination of material quantities. Choice of linings and methods of fabrication have an economic variation affected by locale. Field labor costs vary so that increased preference has accumulated towards shipping completely shop-fabricated vessels in very large diameter or shipment in large assemblies with a minimum of field operations.



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Still good after 8 years on the job. Here is a filter press developed and produced by T. Shriver and Co., Inc., Harrison, N. J. It is equipped with 33 plates and frames cast in Ni-Resist. No appreciable wear or corrosion after 8 years of use attests to the dependability of Ni-Resist in handling highly corrosive potash brine. The user, Niagara Alkali Company of Niagara Falls, N. Y., declares that Ni-Resist gave a 5 or 6 to 1 superiority over cast iron.

NI-RESIST® CASTINGS can save you a lot of money.

Ni-Resist plates and frames in Shriver filter presses, for instance, were good as new after 8 years' use in filtering highly corrosive potash brine.

This is typical Ni-Resist performance.

Actually, no other cast metal provides such a useful combination of engineering properties . . .

It resists corrosive and erosive attacks of acids, alkalies and salts, it's ideal for metal-to-metal wear service, and it provides up to 10 times better resistance to scaling, and up to 12 times better growth resistance than plain iron at temperatures up to 1500°F.

Ni-Resist will meet a specific condition or a combination of requirements. It is available in several types to completely answer a variety of demands.

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Please send me booklets entitled "Engineering Properties and Applications of Ni-Resist" and "Buyers' Guide for Ni-Resist Castings."

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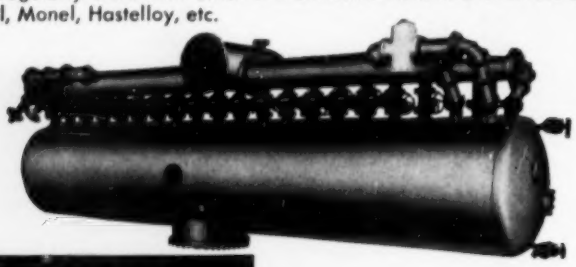
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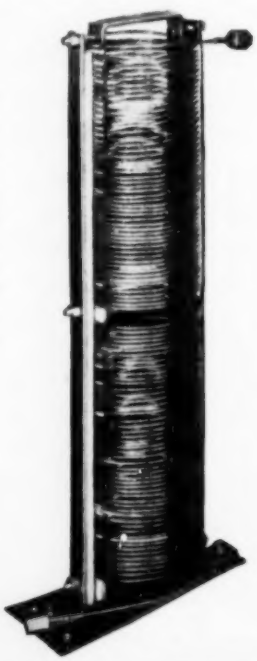
SPECIAL MATERIALS If your requirements call for special materials of construction, Whitlock can help you. Here's just one example — an Ampco tube side exchanger. The 1323 sq. ft. exchanger employed Ampco channels, tube sheets and tubes in a 4-pass, 27" I.D. shell. Units of this type are particularly adapted to process operations where highly corrosive fluids must be handled. We also regularly work with other anti-corrosive materials: stainless steel, nickel, Monel, Hastelloy, etc.



SPECIAL DESIGNS Perhaps you need special design techniques — if you do, Whitlock can help you. For example, this 72" diameter x 388¾" long deaerating vessel was carefully designed against special procedure specifications to preclude distortion in welding. Whitlock Engineers are thoroughly experienced in designing exchangers for difficult operating conditions.

SPECIAL PRESSURES

Perhaps you need an exchanger for elevated pressures like these helical coils furnished for an unusual process condition. The tubing—minimum I.D. equals ¼"—was coiled on a 6" bending diameter subsequent to welding together straight tube lengths. The principal acceptance criterion was the successful completion of a hydrostatic test at 20,000 p.s.i.g. We are regularly manufacturing shell and tube units (for pressures to 3000 p.s.i.g.) and shell and coil units (for pressures in excess of 5000 p.s.i.g.).



For recommendations, write The Whitlock Manufacturing Company, 97 South Street, West Hartford 10, Conn. In Canada: Darling Brothers, Ltd., Montreal.

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

N. Y. ONE-DAY MEETING

(*Continued from page 60*)

are not only aware of this, but believe the risk worth the gamble. The market is a multi-billion-dollar one.

New developments in antibiotics

The field of antibiotics, still one of dramatic discovery, has settled down to a long-range development along chemical engineering lines to achieve maximum economies, according to J. H. Kane and P. Regna (Charles Pfizer and Co.). Mr. Regna discussed the various products that have achieved prominence, and the developmental and manufacturing complexity involved in the production of these materials.

New developments in detergents

Synthetic detergents have nearly completed their conquest of soap for household detergents according to T. H. Vaughn and H. B. H. Cooper (Colgate-Palmolive-Peet) in their presentation of new developments in detergents. These products are now beginning to seriously challenge the bar soap market. Synthetic products have taken over toilet article products with the early general purpose products being supplanted by specially-tailored products to meet specific market demands.

Among the high-foaming type products, the alkyl aryl sulfonated and alcohol sulfonates dominate. With the low-foam non-ionic detergents, those based on ethylene oxide condensation products of alkyl phenols or rosin derivatives are most prominent. Along with these, various foam boosters or depressants are being used as required. The principal synthetic detergents used in toilet articles include the alcohol sulfates, the fatty acid monoglyceride sulfates and sulfonates, and anti-enzyme detergents such an *N*-lauroyl sarcosinate.

Application of the Houdry dehydrogenation process

The great economy and yield of producing butadiene and butenes from normal butane by the Houdry Dehydrogenation Process was presented by G. F. Hornaday and T. A. Burtis (Houdry Process Corp.). This process is well suited to meet the demand for unsaturated hydrocarbons used by various rubber petroleum, and chemical industries for the production of synthetic rubber, high octane gasoline and other syntheses. The process is capable of producing olefins, diolefins or a mixture of the two by a single conversion step from normal paraffins. The process uses a minimum of three adiabatic fixed bed reactors operated on a cycle to maintain continuous flow. Operating conditions are chosen so that the heat required for the

(*Continued on page 77*)

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Field Reports Show Greatly Increased Service Life

To meet the demand for a simple, small, high pressure ammonia valve, Autoclave Engineers, Inc. designed and built the valve shown here to withstand 6000 p.s.i. This design also is manufactured for 15,000 p.s.i. According to pressure and size (A) design provides for ease of operation. Smaller port sizes are furnished with rising stem and larger sizes with non-rising stem, utilizing external anti-friction thrust bearings. To date these (A) valves have lasted 3 times longer in the lines than those which they replaced, and they are still going strong.

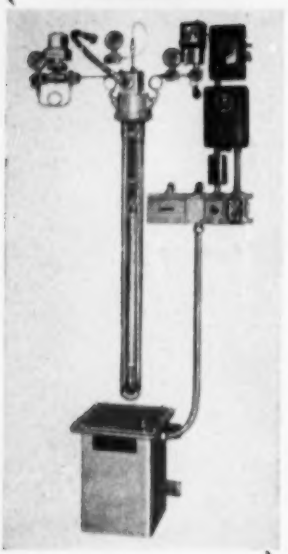
The (A) staff of highly trained designers and engineers, backed up by modern production equipment in the hands of skilled craftsmen, is at your disposal. (A) is well prepared to meet your requirements with diversified high pressure equipment for research laboratory and pilot plant heretofore unavailable in this country. Catalog 200 is yours for the asking.

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SOUTH TEXAS REPORT

(*Continued from page 64*)

POLYETHYLENE

Approximately 75% of the production of polyethylene will come out of the Gulf Coast according to H. Holtz, Bakelite Co. The expansion in this area is attributed to available natural gas and oil refineries which supply the basic raw materials, and the efficient labor.

STATISTICAL QUALITY CONTROL

A recently acquired tool of management, statistical quality control, is making its entry into the chemical process industries. J. Rio of the Texas Division of Dow Chemical reviewed the application of this mathematical technique to the problem of reducing the expense involved in the continuous sampling of a finished product requiring a high degree of purity. The result was a saving in sampling time and costs and also improvement in average product quality.

The analysis of process variables determined that the output variation could be reduced if proper control were placed on the product. It was found, however, that the time delay between the sensing of process changes affecting output quality were long enough to permit drifting in this quality before compensating changes could be made. By plotting the course of the process variables as they drifted from one extreme to the other a control chart was formulated which gave a drift warning in sufficeint time to allow necessary compensations to be made.

SYNTHETIC AMMONIA

Ammonia production is experiencing a rapid growth—18 new plants and expansions were put on-stream in the period of Jan. to Sept. of this year representing 1,045,000 annual tons of synthetic ammonia capacity. In addition, 25 plants are expected to be completed by the end of 1956 contributing approximately another 1,400,000 tons.

Ammonia producing plants are located predominantly in the southern and midcontinent states. Of the 25 new installations in various stages of completion or contemplation over 70% of these will go into this area which already accounts for 70% of the country's synthetic ammonia output. Although 75% of the total fixed ammonia production in the country was consumed by the fertilizer industry there is a noticeable lack of production in the heavy fertilizer consuming areas in the southwest. This is due to a lack of hydrogen or stock from which it can be readily made which is one of the largest single items in determining plant location.—C. H. Davenport.

C. E. P. Monograph and Symposium Series

Most Recent Volume

NUCLEAR ENGINEERING—Part III: This final volume in the nuclear engineering series covers the rest of the papers from the Ann Arbor meeting (Symposium Series No. 13, 275 pages; $3.25 to members, $4.25 to nonmembers). The three Symposium Series volumes on nuclear engineering contain, with the May issue of C.E.P., all the papers presented at the first international congress on the peacetime uses of atomic energy, held at Ann Arbor, Mich., in June, 1954.

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Price of each volume depends on number printed. Series subscriptions, which allow a 10% discount, make possible larger runs and consequently lower prices.

N. Y. ONE-DAY MEETING

(Continued from page 74)

reactors during the on-stream period is substantially equal to that supplied by the combustion of coke during regeneration.

Catalytic desulfurization of petroleum distillate

Various methods of conversion of organic sulfur compounds to hydrogen sulfide and saturated hydrocarbons were reviewed by L. W. Zahnstecher and C. Petraca (Foster Wheeler Corp.). The removal of sulfur from petroleum distillates by catalytic desulfurization is well suited to the need for for the refiner to process high sulfur crudes. Mr. Zahnstecker presented utility and plant costs for a standard unit. The Grey process, cycloversion process, autorefining, hydrofining, hydrodesulfurization and unifining were described. The variation of utility requirements and plant costs for various capacities, liquid hourly space velocities, pressures and hydrogen recycle rates were graphically portrayed. The desulfurization process is generally a mild selective hydrogenation over a cobalt or nickle oxide catalyst at a temperature of 750° F. and 800 lb./sq.in.

Fluid coking and fluid coke

The upgrading of heavy residual oils to gasoline and distillate products in the boiling point range of heating oil and catalytic cracking feed by the Fluid Coking Process was discussed by F. T. Barr and C. E. Jahnig (Esso Laboratories. The economic attractiveness of this process has to do with the valuable liquid products produced and the finely divided coke made as a by product which have potentially high value outlets. Yields, qualities of product and market potentials were brought out along with the results of using a number of feed stocks to show the flexibility of the process.

In the process, hot residuum feed is sprayed into a bed of finely divided fluidized coke in a reactor operating 900° to 1050° F. The liquid feed distributes itself over the surface of the particle and is decarbonized and vaporized. These vapors are subsequently passed through a cyclone and scrubber to remove the coke particles and then to a fractionating tower for separation.



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If you require *extra* qualities in your high alloy pipe, investigate DURASPUN Centrifugally Cast Pipe. We can produce it in OD ranging from 2½" to 24" and in lengths up to 15' according to diameter. Our experience in the field of centrifugal high alloy castings dates back to 1931. Our experience in the field of static high alloy casting goes back to 1922. We can give you good service.

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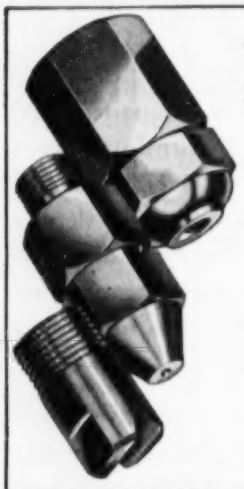
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***Dimension Data,* NEMA Frame 203-587**



New technical data sheets provide diagrams and dimensions for *ACEC Vertical Hollow Shaft Pump Motors,* which are designed for deep well irrigation and industrial pumping application. The motor has an extra large canopy protecting ventilation opening. Unusually large oil reservoirs supply precooled oil for lubrication. Centrifugal fan ventilates the entire motor. Glyptal coated FORMACEC windings withstand both moist and arid atmospheres. Heavy duty thrust bearing completely protected from extraneous matter. Motors equipped with pin type standard reverse protection clutch or optional fitting of ball type non-reverse ratchet. Data sheets and distributor list available from ACEC ELECTRIC CORPORATION, Dept. I, 40 East 49 Street, New York 17, N. Y.



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The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions.

These names are listed in accordance with Article III, Section 8, of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members will receive careful consideration if received before December 15, 1954, at the Office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

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Avery, Henry, *Pittsburgh, Pa.*
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Bromley, Le Roy A., *Berkeley, Calif.*
Coberly, Camden A., *Webster Groves, Mo.*
Fernandez, Jose Mendoza, *Mexico D. F. Mexico*
Frumerman, Robert, *Pittsburgh, Pa.*
Garver, Reed E., *Snyder, N. Y.*
Haney, J. D., *Morgantown, W. Va.*
Hoffmann, Edward J., *Baytown, Tex.*
Jaros, S. E., *Plainfield, N. J.*
Johanson, L. N., *Seattle, Wash.*
Leonard, Jack C., *Dayton, Ohio*
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McCrillis, Edwin, *Wichita, Kan.*
McLellan, Donald E., *Sarnia, Ont., Can.*
Meckley, Le Roy S., *Easton, Pa.*
Miller, Ernest P., *Rifle, Colo.*
Nurmi, Eugene, *Oak Ridge, Tenn.*
Reed, George G., *Jr., Brooklyn, N. Y.*
Roen, Charles B., *St. Louis, Mo.*
Small, Robert J., *University City, Mo.*
Stallings, P. S., *Jr., Phillips, Tex.*
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Brooks, Charlie R., *Jr., Knoxville, Tenn.*
Browne, Ralph R., *Brooklyn, N. Y.*
Buchwald, Elias, *New York, N. Y.*
Caldwell, Calvin G., *Washington, D. C.*
Cantoni, Aldo, *Haifa, Israel*
Chalkley, Roger, *Fort Mitchell, Ky.*
Chilenskas, Albert A., *Lemont, Ill.*
Cirotski, Leo G., *Painesville, Ohio*
Clark, Joseph W., *Phillips, Tex.*
Courtney, Brian F., *Livingston, N. J.*
Crawford, Jonathan, *Cleveland Heights, Ohio*
Crowl, James S., *Hammond, Ind.*
Cutler, Albert M., *Malden-on-Hudson, N. Y.*
Danielson, Daniel T., *Marcus Hook, Pa.*
Dennis, D. E., *Gainesville, Ga.*
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Derr, W. Rodman, *Jr., Woodbury, N. J.*
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Erikson, Ted, *Oak Lawn, Ill.*
Evans, John A., *Rockville Centre, N. Y.*
Fontaine, Marc, *Hopewell Junction, N. Y.*
Fredrickson, Clair D., *Cincinnati, Ohio*
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Gilbert, Newman R., *Aiken, S. C.*
Gill, Robert, *Philadelphia, Pa.*
Glassman, Arthur Jay, *Brooklyn, N. Y.*

(Continued on page 80)

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N. Y.

Pfaudler Acid-alkali-resistant Glass Now Standard on Glassed Steel Units for Severe Chemical Service



Both of these glassed steel discs were exposed to buffered caustic soda (pH 11.5) at 212°F. for 30 days. Acid-alkali-resistant glass (above) was unaffected.



Above, note how the high-quality glass which was formerly used in Pfaudler glassed steel vessels was severely etched.

On September 1, 1954, acid-alkali-resistant glass became standard for all Pfaudler glassed steel equipment for severe chemical service. This new glass was first introduced to the chemical industries in November, 1951, and has been available as "special" since then.

Almost universal corrosion resistance

Wide and varied field experience over the past three years fully verified the original expectations for this glass—it has acid resistance equal to or better than the previous standard glass and, in addition, it is *three times as resistant* to corrosion by alkaline solutions.

Specifically, this glass is resistant to corrosion by all acids (except hydrofluoric), even at elevated temperatures and pressures, and to alkaline solutions up to pH 12 and 212°F.

10% price reduction

As "special," acid-alkali-resistant glass carried a 10% premium charge over the former standard glass. Now as a standard, this premium is eliminated and it will be available at no increase in price.

Acid-alkali-resistant glass, like the former standard, is deep blue in color. To permit identification, there is a glass number on the name plate of every Pfaudler vessel. At present, the number "53" is being used to designate the new standard glass while the number "42" designates the former standard. A new numbering system for easier identification is now in process. Full details will be included in a later issue of "Corrosioneering News."

Field experience "proves in" acid-alkali-resistant glass

A 1,000-gallon oxidation kettle, lined with acid-alkali-resistant glass, was placed in use 3½ years ago, processing sodium hypochlorite bleach containing 12-15% free chlorine. It produced 3,694 batches before showing noticeable wear. This is more than three times as many batches as were possible with regular high-grade Pfaudler glass.



"WORKHORSE"

Heat Exchanger Solves Cleaning, Gasket Problems

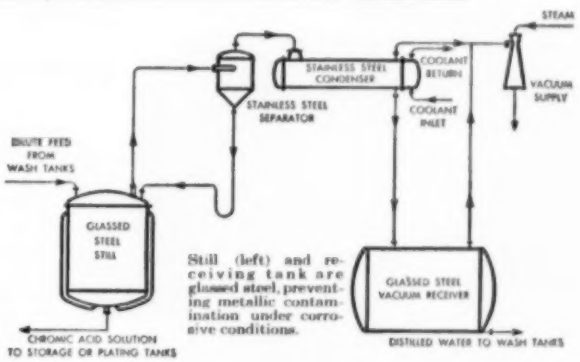
The nonremovable tube bundle of Pfaudler's Type FTS (fixed tube sheet) heat exchanger has won friends throughout the chemical processing industries. A money-saver, it simplifies cleaning and eliminates gasket problems.

The shell is permanently welded to the tube sheets, doing away with *all* gaskets or packed joints on shell side. There are *no* internal gaskets—no possibility of leakage or intermixture of hot and cold fluids.

Low First Cost

Original cost of Type FTS heat exchanger is low, because of its simple construction and standard design. Upkeep is low, because tubes are easy to clean, and you eliminate the problem of replacing gaskets or purchasing costly special gasket materials.

For complete data on this cost-cutting "workhorse," write for Bulletin 837.



Still (left) and receiving tank are glassed steel, preventing metallic contamination under corrosive conditions.

Packaged system recovers chromic acid

In plating operations, you can get substantial savings by the recovery of chromic acid from waste rinse water.

You do this easily with a Pfaudler chromic acid recovery system—a standard "packaged" system designed and fabricated by Pfaudler process engineers.

The system simply evaporates some of the waste wash water returning the balance to plating strength. This is then piped back to the plating tank. The distilled water obtained by the evaporation process is reused as pure wash water.

The Pfaudler system makes use of stainless steel for contact with pure water, while glassed steel protects equipment which must resist direct attack by the hot 24% to 45% chromic acid solution. Field experience and laboratory tests have both proven conclusively that acid-resistant glassed steel is the only practical material to withstand this attack.

Standard chromic acid recovery systems are available in capacities of 200, 300, 500 and 1,000 gallons. Often these systems pay for themselves within six months. One midwestern plant saved $42,000 a year by installing a Pfaudler system.

Write for Bulletin 914, which describes these systems in detail.

Try HELIX

POTTING COMPOUND P-420

- A thermosetting epoxy-based compound that cures at room temperature.
- Non-porous and has excellent adhesion to wiring and other compounds.
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A liquid which is poured cold, will cure WITHOUT BAKING AND A VERY MINIMUM OF SHRINKAGE.

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(*Continued from page 78*)

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Gould, Thurman W., Jr., *West Jonesport, Me.*
Greenlee, Norman, *Corydon, Iowa*
Gregory, Thomas W., *Massena, N. Y.*
Gumerman, Carl, *Philadelphia, Pa.*
Hanson, Donald O., *Dahlgren, Va.*
Harvie, William J., *New Brunswick, N. J.*
Hearn, John S., *El Dorado, Ark.*
Heiny, Richard L., *Midland, Mich.*
Herzig, Howard, *Brooklyn, N. Y.*
Hunt, Charles Bradford, *Dhahran, Saudi Arabia*
Inskeep, Mark D., *Saddle River, N. J.*
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Jacoby, Charles R., *Granite City, Ill.*
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Malthaner, J. C., *Beaver, Pa.*
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Morrison, E. Clark, Jr., *Charleston, S. C.*
Newmark, Paul, *Brooklyn, N. Y.*
Niles, Ernest A., *Mayfield, N. Y.*
Norris, James C., *Houston, Tex.*

(*Continued on page 82*)

CONSECO

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▲ 9000 sq. ft. "Conseco" condenser for southeastern utility — one of 4 units installed at this plant.

◀ 3500 sq. ft. "Conseco" condenser serving the turbine drive of the main air compressor in a southwestern refinery.

Hundreds of successful, trouble-free installations, ranging in capacity from the smallest to the largest, and including all types, have been designed, built, and installed for a long list of exacting industrial users in all parts of the world.

Some "Conseco" features are:

- deep water boxes
- wide tube spacing
- outside steam belt
- internal stiffening

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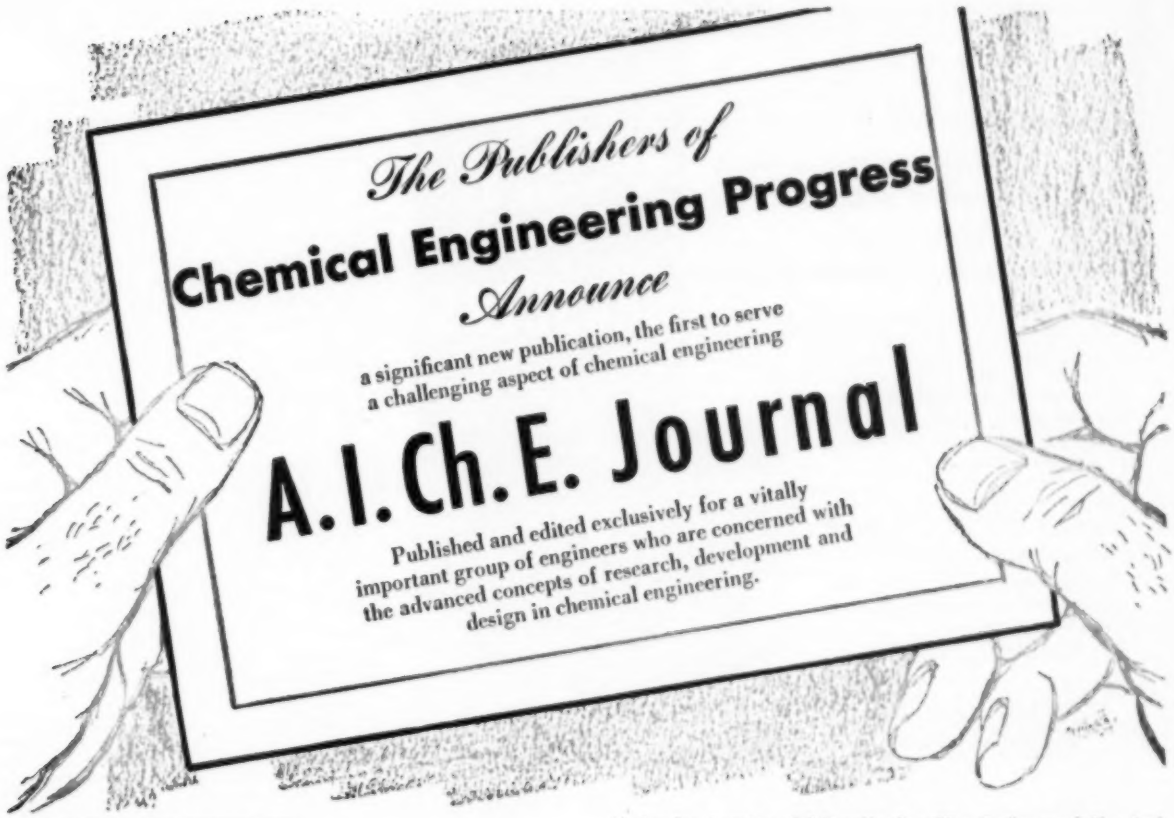
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This specialist

is first of all a chemical engineer. He is more than a chemist because the basic data of his research is aimed at the *engineering* of new processes and new equipment that will be applied in industry.

Having grown so rapidly

in scope, importance and influence in so many fields, this chemical engineering specialist is difficult to classify, measure and catalog. Yet inextricably woven into his growth is his professional group—the American Institute of Chemical Engineers. The interests of the entire chemical engineering fraternity, of which this specialist is a small but important part, have been fostered and promoted by the activities and services of the A.I.Ch.E.—including a vigorous publishing program built around *Chemical Engineering Progress*, the *Symposium Series*, and the *Monograph Series*, of which the latter two are not advertising media.

Now the time has arrived

when this group of chemical engineering specialists within the Institute can best be served by a publication devoted completely to their particular interests. To satisfy this need, and as a part of our growing publishing program, the Institute will begin publication of the A.I.Ch.E. Journal in March, 1955. It will be issued quarterly.

Under the direction of Editor Harding Bliss, Professor of Chemical Engineering at Yale University, the A.I.Ch.E. Journal will be devoted to:

1. Research results based on new data.
2. New devices, tools, instruments for research, development and design.
3. New theoretical and statistical methods.
4. New correlations.
5. Process design, kinetics, thermodynamics, etc.
6. Research projects in allied branches of engineering, chemistry or physics.
7. General topics of value to educators and researchers.

We realize at the outset

that because of the highly technical nature of its editorial content, the A.I.E.Ch.E. Journal will in the beginning have a circulation limited to a relatively small group of 2500. It is our single objective to make the Journal fill a definite need heretofore never completely satisfied.

We are also well aware

of the great influence advertising pages in the Journal will exert for imaginative manufacturers of process and control equipment. Because its circulation is concentrated, the Journal will penetrate to the very heart of a vitally important group of engineers in the vanguard of the chemical engineering field.

F. J. Van Antwerpen
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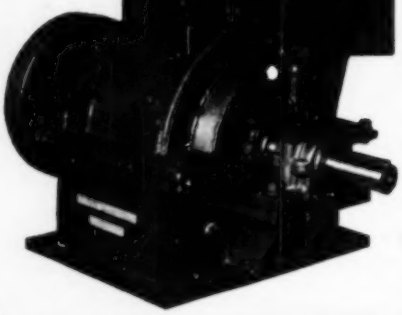
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CANDIDATES

(*Continued from page 80*)

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Papacosta, Constantine G., *Brooklyn, N. Y.*
Perez, Donald E., *New Orleans, La.*
Polashock, Michael S., *Linden, N. J.*
Porter, Floyd B., Jr., *Waterbury, Conn.*
Poznick, Daniel E., Jr., *Woodbury, N. J.*
Puyear, Donald E., *Hayti, Mo.*
Quilici, Robert Ernest, *San Francisco, Calif.*
Raines, Gilbert E., *Walland, Tenn.*
Rich, Willson C., Jr., *Norwood, Pa.*
Saroppo, John W., *New Castle, Del.*
Sander, Robert C., *Lehighton, Pa.*
Sands, Donald W., *Newport, Ind.*
Santangelo, Joseph G., *Passaic, N. J.*
Schramm, Charles K., *Brooklyn, N. Y.*
Senese, J. G., Jr., *Charleston, W. Va.*
Shaw, Raymond C., *Wickford, R. I.*
Shiah, Joseph T., *Niagara Falls, N. Y.*
Simons, F. Holmes, *Mt. Pleasant, S. C.*
Smith, William E., *Anaheim, Calif.*
Sorg, Ronald, *Florette, Pa.*
Stainker, Stanley H., *Gloucester, N. J.*
Stevens, Richard L., *Cleveland, Ohio*
Strohl, Kenneth P., *Coraopolis, Pa.*
Summerville, Robert N., *Cincinnati, Ohio*
Sykes, Horace Fennell, V, *Ridley Park, Pa.*
Thomas, Robert L., *Trona, Calif.*
Thurston, Richard A., *Argo, Ill.*
Toe, John J., *Midland, Mich.*
Tumeinski, Ronald F., *New Bedford, Mass.*
Valley, A. J., *Port Arthur, Tex.*
Vedeler, B. Chris, Jr., *Bergen, Norway*
Wall, James Richard, *Ames, Iowa*
Weir, Douglas, *Wauwatosa, Wis.*
Wells, Albert J., Jr., *Riverside, R. I.*
Whitaker, Stephen, *Newark, Del.*
Willoughby, William, II, *Orange, Tex.*
Yemin, Lowell, *Ann Arbor, Mich.*
Zeleny, Richard A., *Nutley, N. J.*

Affiliate

Briceno, Paulo Gonzalez, *Caracas, Venezuela D. F.*
Meaux, Edward P., *el Dorado, Ark.*

NEWS

(*Continued from page 42*)

CHEMICAL ENGINEERING FACULTY LIST PUBLISHED

"Chemical Engineering Faculties" has been published in a 1954-55 edition by the Chemical Engineering Education Projects Committee of A.I.Ch.E., under the direction of Professor Kenneth A. Kobe, of the University of Texas. The fourth edition of the booklet surveys faculty, accrediting by the Institute, number of 1953-54 graduates, and college placement officers for 10 Canadian and 114 American schools. This information has been widely used by industrial personnel men. Copies of the publication are available from the Executive Secretary, A.I.Ch.E., without charge.

HOW CLASSIFIER CAME INTO MINERALS PROCESSING SERVICE

A classifier which though seemingly well-designed had never found substantial commercial application, was successfully applied through the use of an intra-company committee technique, according to W. H. Withington of Hardinge Company (York, Pa.). The story of the trials of an equipment manufacturer in finding the optimum application for a specialized item of unit operations equipment, was unfolded at a round table discussion during the October meeting of the Chemical Equipment Sales Engineers Association, at the Chemists' Club in New York City.

The classifier involved was too heavy in construction features to be competitive for most aqueous solution clarification service. To find its proper place, Hardinge organized a group of committees along industry lines, each as a separate task force to try to find suitable application. Committee membership included both home office and field personnel, chosen on basis of familiarity with markets as well as by geographic location. Each committee reported at three-month intervals to the general chairman. Within a relatively short time the apparently-optimum application was found to be for heavy media concentration, in the mineral dressing field. A concerted marketing effort resulted in a happy outcome, both for equipment manufacturer and user.

Somewhat similar techniques were reported as having been employed to enlarge the field of application for a pulverizer and a rotary filter according to reports presented by S. B. Kanowitz (Raymond Pulverizer) and H. M. Small (Filtration Engineers).

S. A. Lewis
(U.S. Stoneware)

ARE YOU A SALES ENGINEER FOR PROCESS EQUIPMENT? OFFICE WITHIN 50 MILES OF NEW YORK? IF SO, READ THIS—

The Chemical Equipment Sales Engineers Association (a New York group—ed.) is inviting interested persons to make application for membership. This organization, now three years old, holds monthly luncheon meetings in the Chemists' Club in New York City. A variety of programs is presented—round table discussions and talks by outsiders such as purchasing agents, process designers, etc. Requirements for membership include chemical engineering degree or equivalent in equipment sales experience, and an office within 50 miles of New York City. The Association will be glad to have eligible prospective members as its guests at a luncheon meeting. Those interested should contact the secretary, J. T. Costigan, c/o The Sharples Corp., 501 Fifth Ave., N. Y., N. Y.

AIR POLLUTION



How To Make Your Smoke Stack Act Taller Than It Is!

New wind operated, automatic controller energizes forced draft or heat systems under unfavorable meteorological conditions . . . thereby increasing "effective stack height." It's called The Bendix-Friez Windtrol*.

Meteorologists, studying smoke behavior under almost all kinds of turbulence, temperature and humidity conditions have come up with some basic answers for forecasting smoke behavior.

TAKE THIS SITUATION

For example, the plant that we're talking about has a relatively low stack. The release of fly ash with its stack effluent results in many complaints under certain meteorological conditions. How can this be corrected . . . without great expense? Let's see what the principles of stack meteorology can show us.

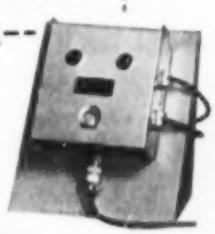
By checking wind speed and direction . . . unfavorable quadrant can be discovered. First, you install at near stack height the Bendix Windtrol Transmitter. This detects the wind speed and direction. The unfavorable quadrant is established for air pollution and the controller (located indoors on any convenient wall) is wired accordingly. The controller is then connected to a forced draft fan, a booster blower or a stack oil burner.



HOW IT WORKS

The transmitter of the Windtrol has been constructed so that the controller circuit is energized when the wind speed is less than a selected value, and the wind direction is from a specified arc. Normally, it is wired so that both conditions must exist simultaneously for the circuit to be energized.

Observations indicate that many situations will arise because of the gustiness of the wind in which either or both, the direction and speed will oscillate rather rapidly in the vicinity of the selected limits. This could result in intermittent and short period closures of the controlling circuit, were it not for a built-in time delay device which causes the actuating power relay to remain open or closed for a given length of time after the direction or speed has changed from the required limits.



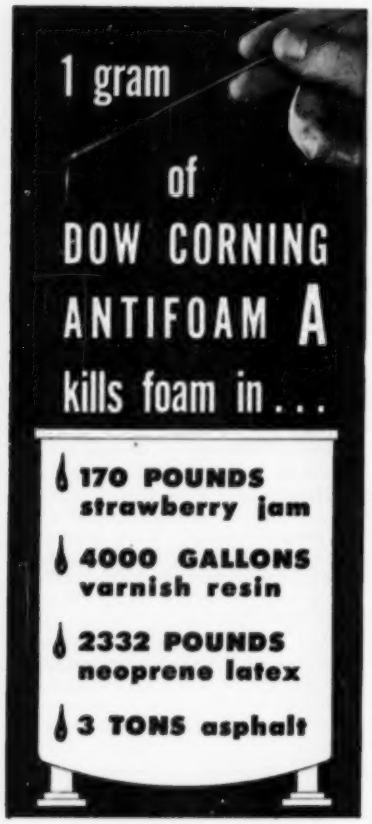
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1. Control stack effluents for selected quadrants and speed.
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3. Eliminate guess-work warnings.
4. Automatically introduce counter-odorants.
5. Operate air-cleaning devices for selected wind directions and wind speeds.

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FUTURE MEETINGS and Symposia of the Institute

MEETINGS **SYMPOSIA**

■ ANNUAL—NEW YORK, N. Y.

Dec. 12-15, 1954. Statler Hotel.

TECHNICAL PROGRAM CHAIRMAN: G. T. Skaperdas, Assoc. Dir., Chem. Eng. Dept., M. W. Kellogg Co., 225 Broadway, N. Y. 7, N. Y.

ASST. CHAIRMAN: N. Morash, Titanium Div., National Lead Co., P. O. Box 58, South Amboy, N. J.

Gas Absorption **Reaction Kinetics**

Biochemical Engineering **Solvent Extraction**

New Processes Utilizing Moving Beds

Business Organization for the Chemical Industry

Deadline Past

■ LOUISVILLE, KY.

March 20-23, 1955. Kentucky Hotel.

TECHNICAL PROGRAM CHAIRMAN: R. M. Reed, Tech. Dir., Gas Proc. Div., The Girdler Corp., Louisville 1, Ky.

Heat Transfer

CHAIRMAN: R. L. Pigford, Div. of Chem. Eng., Univ. of Delaware, Newark, Del.

Propellant Power

CHAIRMAN: R. A. Cooly, Explosives Div., Olin Mathieson Chemical Corp., East Alton, Illinois.

Industrial Relations

CHAIRMAN: Samuel L. H. Burk, Dir. Personnel Administration, General Foods Corp., White Plains, N. Y.

Centrifugation

CHAIRMAN: J. O. Maloney, Chairmen, Dept. Chem. Eng., Univ. of Kansas, Lawrence, Kan.

Deadline—November 20, 1954

■ HOUSTON, TEXAS

May 1-4, 1955. Shamrock Hotel.

TECHNICAL PROGRAM CHAIRMAN: J. L. Franklin, Res. Assoc., Humble Oil & Refining Co., P. O. Box 1111, Baytown, Texas.

Nucleation Processes

CHAIRMAN: D. W. Oakley, Plant Mgr., Metal & Thermit Corp., 1 Union St., Carteret, N. J.

Flow of Fluids Through Porous Media

CHAIRMAN: H. Dayton Wilde, Mgr. Res. Div., Humble Oil & Ref. Co., Box 2180, Houston 1, Tex.

Extractive and Azeotropic Distillation

CHAIRMAN: Dr. D. E. Holcomb, Dean of Eng., Texas Technological College, Lubbock, Tex.

Chemical Engineering Curricula

CHAIRMAN: Dr. J. W. Mason, Dean of Eng., Georgia Inst. of Tech., Atlanta, Ga.

Differences in Chemical Engineering Theory

CHAIRMAN: Dr. F. A. Landee, Dow Chemical Co,. Midland, Michigan.

Deadline—January 1, 1955

■ LAKE PLACID, N. Y.

Sept. 25-28, 1955. Lake Placid Club.

TECHNICAL PROGRAM CHAIRMAN: L. J. Coulthurst, Chief Proc. Designer, Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

Process Engineering Organizations

CHAIRMAN: J. F. Thornton, Pres., The Lummus Co., 385 Madison Ave., New York 17, N. Y.

Growth of the Oil & Chemical Industry by Integration

CHAIRMAN: Mr. J. J. Simpson, Petroleum Chemicals Inc., 54 Wall St., New York 5, N. Y.

Deadline—May 25, 1955

■ ANNUAL—DETROIT, MICH.

Nov. 27-30, 1955. Statler Hotel.

TECHNICAL PROGRAM CHAIRMAN: T. J. Carron, Supervisor, Chem. Eng. Section, Ethyl Corp., Res. Labs., 1600 West Eight Mile Road, Detroit 20, Mich.

Photochemical Processes

CHAIRMAN: Prof. J. J. Martin, Dept. Chem. Eng., Univ. of Michigan, Ann Arbor, Mich.

Biochemical Engineering

CHAIRMAN: Dr. H. O. Halvorsen, Dept. of Bacteriology, Univ. of Illinois, 362 Noyes Lab. of Chem., Urbana, Illinois.

Technical Societies Cooperation with Chemical Engineering Industries

CHAIRMAN: Prof. J. B. Phillips, Dept. Chem. Eng., Phys. Sciences Centre, McGill Univ., Montreal 2, Canada.

Deadline—July 27, 1955

■ LOS ANGELES, CALIF.

Feb. 26-29, 1956. Statler Hotel.

TECHNICAL PROGRAM CHAIRMAN: T. Weaver, Proc. Eng., The Fluor Corp., Ltd., Box 7030, East L. A. Station, Los Angeles 22, Calif.

Deadline—Oct. 26, 1955

■ ANNUAL—BOSTON, MASS.

Dec. 9-12, 1956. Hotel Statler.

TECHNICAL PROGRAM CHAIRMAN: W. C. Rousseau, Proc. & Sales Eng., Badger Mfg. Co., 230 Bent St., Cambridge 41, Mass.

Deadline—August 9, 1956

UNSCHEDULED

Extraction of Hydrocarbons for Chemical Use from Pipeline Gases

CHAIRMAN: E. E. Frye, J. F. Pritchard & Co., 210 W. 10th, Kansas City 5, Mo.

Bubble Mechanics

CHAIRMAN: Prof. R. C. Kintner, Dept. Chem. Eng., Ill. Inst. of Tech., 3300 Federal St., Chicago 16, Ill.

Fundamental Mechanisms in Boiling Cavitation and Condensation

CHAIRMAN: R. R. Hughes, Shell Development Co., Emeryville, Calif.

Extraction of Hydrocarbons for Chemical Use from Pipeline Gases

CHAIRMAN: E. Frye, J. F. Pritchard & Co., 210 W. Tenth St., Kansas City 5, Mo.

AUTHOR INFORMATION

Submitting Papers

Members and nonmembers of the A.I.Ch.E. who wish to present papers at scheduled meetings of the Institute should follow the following procedure.

First, write to the Secretary of the A.I.Ch.E. Mr. S. L. Tyler, American Institute of Chemical Engineers, 25 West 45th Street, New York, requesting three copies of the form "Proposal to Present a Paper Before the American Institute of Chemical Engineers." Complete these forms and send one copy to the Technical Program Chairman of the meeting for which the paper is intended, one copy to the Assistant Chairman of the A.I.Ch.E., Program Committee, address at the top of this page, and one copy to the Editor of Chemical Engineering Progress, Mr. J. B. Mellecker, 25 West 45th Street, New York.

If you wish to present the paper at a particular symposium, request 4 copies of the proposal sending a copy to the Chairman of the symposium.

Before Writing the Paper

Before beginning to write your paper you should obtain from the meeting Chairman, or from the office of the Secretary of the A.I.Ch.E., at 25 West 45th Street, New York, a copy of the A.I.Ch.E. Guide covers the essentials required for submission of papers to the A.I.Ch.E. or its magazines.

Copies of Manuscript

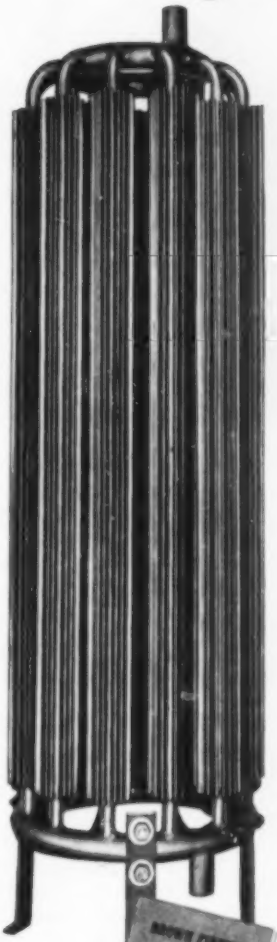
Five copies of each manuscript must be prepared. For meetings, one should be sent to the Chairman of the symposium, and one to the Technical Program Chairman of the meeting at which the symposium is scheduled. If no symposium is involved, the two copies should be sent to the Technical Program Chairman. The other copies should be sent to the Editor's office. All manuscripts submitted to the A.I.Ch.E. Editor are automatically considered for C.E.P., the A.I.Ch.E. Journal, and the Symposium Series. Presentation at a meeting is no guarantee that manuscripts will be accepted.

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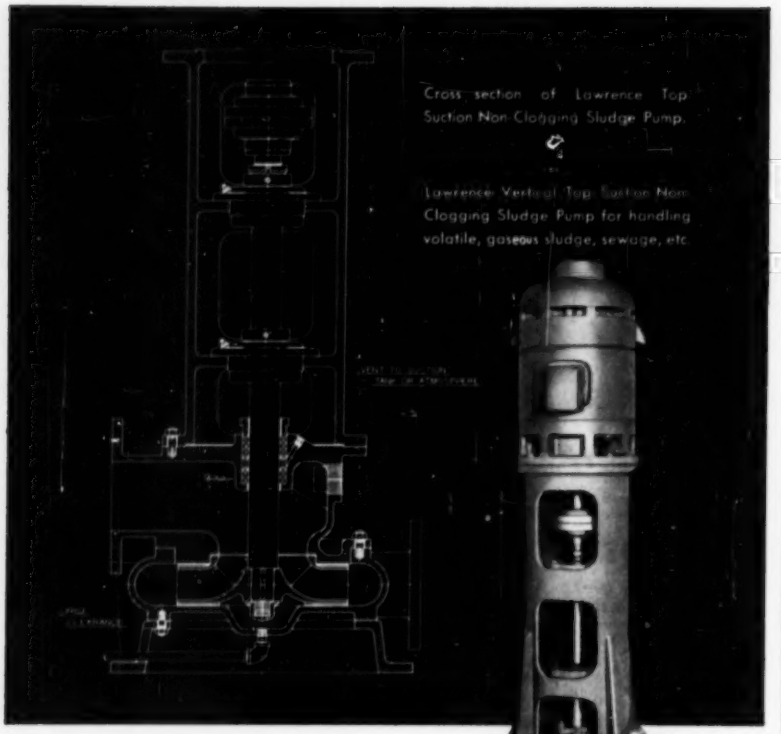
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nuclear engineering division

A copy of minutes of October 16 meeting in New York City of the program committee of the Nuclear Engineering and Science Congress, of Engineers Joint Council, has been received and is quoted from as follows:

"Times and places for the proposed Congress were discussed. The following locations and dates are available: Philadelphia July 25-August 1; Purdue open up to August 2; University of Minnesota the week of July 11 and/or July 18; (Cornell University has also indicated an interest).

"Each of the representatives of the cooperating societies [of which the A.I.Ch.E. is one—ed.] commented in turn on the organization for nuclear energy within his society and the part they would be prepared to play in conducting the nuclear Congress. The A.I.Ch.E. represented by J. J. Martin and M. C. Leverett [offered the following subjects as probably available in the form of principal topics or categories for technical sessions]: Liquid metals, heat transfer, radiation and sterilization and chemical manufacture, preparation of radioactive sources, processing of spent fuels, and temperature coefficients for reactors—5 technical sessions.

"Mr. F. J. Van Antwerpen reported that the A.I.Ch.E. plans to conduct an Atomic Exposition, enlarged over that held in 1954 in connection with the Nuclear Engineering Congress at Ann Arbor. He indicated that [the A.I.Ch.E.] preferred to hold it in conjunction with the Nuclear Congress.

"The organizational meeting of the American Nuclear Society on October 11 and its press release was noted. After * * * * discussion regarding the relations between the E.J.C. General Committee and the A.N.S. it was

VOTED To investigate with the A.N.S. the possibility of holding a Nuclear Congress at a time and place mutually agreeable to all participating societies, with the understanding the A.N.S. would cooperate on the same basis as the other societies.' (Passed unanimously.)

"The executive group of the A.N.S. will be contacted for the purpose of exploring the above resolution. E. Paul Lange, secretary, and Donald L. Katz, chairman."

The reader is reminded that at the September 20 meeting of the general committee of E.J.C., motions were passed to the effect that the Nuclear Congress referred to above would be held providing that the proposed Presidential Congress will, in 1955, either not be held in the U.S. or be held abroad. (C.E.P. —October, 1954.)

News of the Field
FROM LOCAL SECTIONS

Chicago Section. Bringing engineers into executive positions results in their being less involved in engineering and more interested in people according to G. W. Heidrick at the Oct. 13 meeting of the Chicago Section. Mr. Heidrick, Heidrick & Struggles, in his talk "Developing Engineers Into Executives" said that engineers are usually "thing minded" whereas executives have to be "people minded." This was the first meeting of the 1954-55 season for the Chicago Section and was attended by 158 members and guests.

—H. E. Gross

Cleveland Section. A social gathering in the form of a dinner-meeting was attended by 78 members of the Cleveland Section on Sept. 28 at the Cleveland Engineering Society Building. B. Burt, past National president, presented certificates of appreciation to past officers of the Cleveland section for the years 1945 through 1953. At the meeting the forthcoming Chemical Professions Dinner was announced. Cards, billiards, bowling and beer were enjoyed after the meeting.

—D. L. Porter

Sabine Area Section. "Investments in the Chemical and Petroleum Industries" was the subject of a talk given by Mr. H. E. Ott to a meeting of the Sabine Area Section on Oct. 5 in Port Arthur, Texas. Mr. Ott is an account executive for the firm of Merrill Lynch, Pierce, Fenner & Beane. About 75 members heard this talk at the first meeting of the 1954-55 season.

—W. E. Norris

Twin Cities Section. A catalytic cracker and a topping plant of the Northwestern Refinery Co. were visited at a Sept. 14 meeting of the Twin Cities Section. Flow sheet and operations of the 4,000 BPD cat cracking unit, a recent addition to the facilities of the plant, and the 8,000 BPD capacity topping plant were explained by J. Vyn, Chief Chemical Engineer.

—A. J. Madden, Jr.

Western New York Section. A recent meeting of the executive committee of the Western New York Section named H. B. Addoms as chairman and W. C. Greenwald as vice-chairman. J. W. Casten, the former president, was transferred to California.

—F. A. Cox

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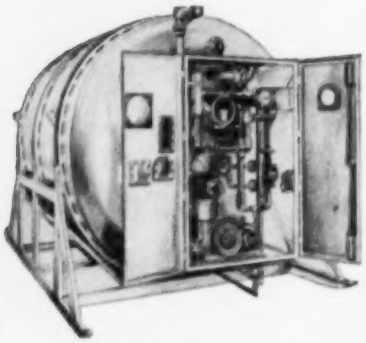
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PEOPLE

W. T. NICHOLS JOINS ARTHUR D. LITTLE, INC.



William T. Nichols, Past President of the American Institute of Chemical Engineers and until recently associated with the Monsanto Chemical Co., has joined the staff of Arthur D. Little, Inc. In the words of E. P. Stevenson, Arthur D. Little's president, Mr. Nichols will bring to his new assignment "a comprehensive knowledge of research and development, engineering, corporate development, and the application of management methods to tehcnical operations."

A graduate of the University of Pittsburgh, Mr. Nichols is currently a member of the University's Engineering Advisory Council.

At Monsanto, Mr. Nichols was assistant to the vice-president for research and engineering and had earlier been director of the firm's general engineering department. During his nineteen-year affiliation with the Westvaco Chemical Corp. he devoted considerable time to new chemical manufacturing projects in the Intermountain area.

ARMISTEAD TAKES HIS TALENTS TO GREECE

The Greek Government has appointed George Armistead and Company of Washington, D. C., headed by George Armistead, Jr., consulting engineers to assist and advise in connection with plans for the projected 30,000 bbl. refinery in that country. This company has been active for many years in furnishing engineering and operating services to refiners in the United States.

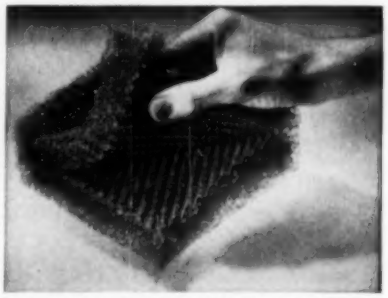
Last year George Armistead, a member of A.I.Ch.E. Industrial Waste Disposal Committee, was appointed member of the Board of Registration for Professional Engineers by the Commissioners of the District of Columbia and will serve for five years as the chemical engineering representative. He has worked in many phases of the petroleum industry and has long been interested in industrial safety and fire prevention. His article in C.E.P. (January, 1952, page 5) gave an account of the chemical engineer's concern with safety because of the expansion of the chemical industries.

Loren D. Grubb, assistant superintendent at the Ponca City refinery, was recently promoted to superintendent of the refinery, Continental Oil Co.

(Advertisement)

Liquid Carry-Over Economically Controlled by Separators Made of Knitted Wire Mesh

When the removal of unwanted – and often contaminating – liquid particles entrained in a gas is considered as basically similar to the filtering of solid particles from the same type of carrier, the simplicity and effectiveness of knitted wire mesh entrainment separators is more readily understood.



Small section of a Metex Mist Eliminator opened to show construction.

Known as Metex Mist Eliminators, these separators are built up from layers of knitted wire mesh into a unit, foraminous in structure, which removes the liquid particles by impingement and accumulation in depth. Though operating on the same principle as air filters of this type, they have one distinct advantage. The filtrant being liquid will drain from the Mist Eliminator by gravity. Entrainment removal can therefore be considered as a "continuous" rather than a "batch" operation since the "filter" does not have to be cleaned.

Metex Mist Eliminators were first used about 10 years ago to remove the liquid entrainment in a fractionator tower in one of our leading petroleum refineries. The efficiency of, and the operating economies effected by, this first installation have since been repeated in unnumbered operations which include not only petroleum refining, but petrochemical and chemical processing operations in this country and abroad.

Mist Eliminators can be easily installed in new or existing vessels. They have no moving parts to require power or servicing and need no special housings. Experience shows that they will operate ever an unusually wide range of velocities with a pressure drop generally less than 1" of water. Entrainment removal efficiencies of 99% and better are commonly reported. For full information write Entrainment Separator Department, Metal Textile Corporation, Roselle, New Jersey.



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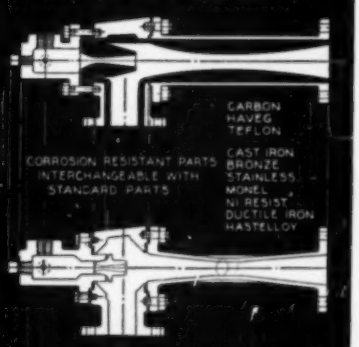
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Harold Mazza, research process engineer for American Potash & Chemical Corp., Trona, Calif., has been appointed assistant director of research to direct the activities of the new products division at the Trona Research Laboratory. He joined the company shortly after his graduation from the University of California with a B.A. degree in chemistry. Since joining the company, he has done extensive work in production and research departments, including such posts as sulfate potash chemist, bromine boss, research chemist, research engineer, and new process engineer.



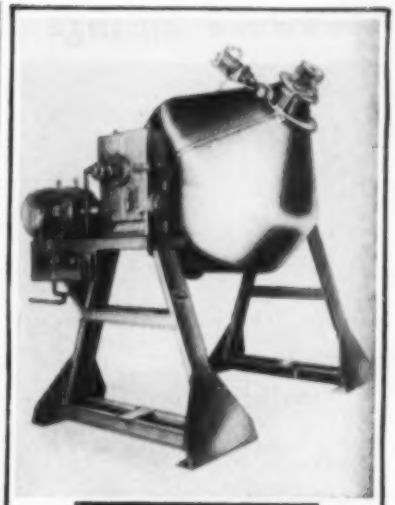
MEES HONORED BY FRANKLIN INSTITUTE

The top annual award of the Franklin Institute has gone to **C. E. Kenneth Mees,** vice-president in charge of research, Eastman Kodak Co., Rochester, N. Y., who rounded out forty years of service in that company in 1952. He was honored for "his many outstanding contributions to the scientific knowledge of the photographic process."

During World War I, Dr. Mees established the first school of aerial photography at Kodak Park and in 1918 added a department of synthetic organic chemistry to Kodak research laboratories. Born in England, Dr. Mees went with Kodak, Ltd., London, where he served for about one year as European representative. Subsequently he became a director of Kodak and still later a vice-president. Dr. Mees was the recipient several years ago of the Adelskolds' gold medal of the Photographic Society of Sweden for his contributions to the progress of photography. He was a member of the firm of Wratten and Wainwright in England early in his career.

J. E. Summerville, a field service engineer for Hall Laboratories, Inc., in its Birmingham, Ala., district office, has been appointed a member of the headquarters staff of the Pittsburgh, Pa., water treatment consulting firm. He has previously worked out of the St. Louis and Pittsburgh offices of the company. Mr. Summerville is a graduate of the Carnegie Institute of Technology.





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Second Prize—Publication of "Oil shale retort, U.S.B.M.—Rifle, Colo." by Robt. E. Lenz, Monsanto Chemical Co., St. Louis, Mo.

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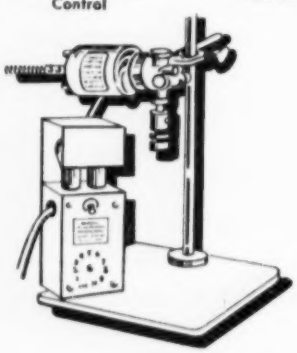
J. C. Dart, Houdry Process Corp., Marcus Hook, Pa.; N. B. Hjersted, Standard Oil Co., Independence, Mo.; C. L. Schmidt, National Lead Co., South Amboy, N. J.

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Douglas M. Considine, for fourteen years associated with the Minneapolis-Honeywell Regulator Co., assumed the responsibilities of sales promotion and merchandising manager of P. R. Mallory & Co., Inc., effective Oct. 1. Starting as a member of the engineering staff of Honeywell's industrial division, he joined the market extension department during its early development and later became its manager. In that capacity he was responsible for many innovations in the integration of advertising and merchandising with related sales activities. Mr. Considine has served on the executive committee and the editorial board of the Instrument Society of America and is a former vice-president of the Eastern Industrial Advertisers Association. He has been chairman of two symposia (A.I.Ch.E.) on automatic controls.



James F. Lemen has recently joined the staff of Hooker Electrochemical Co., Niagara Falls, N. Y. Prior to this association he worked on chemical development at Pierce and Stevens, Inc., in Buffalo and later on quality control at the O-Cel-O division of General Mills, Inc. He was graduated from Clarkson College of Technology in 1951 with the B.S. in chemical engineering.

William P. Gage and **Marlin G. Geiger** have been elected vice-presidents of W. R. Grace & Co. Both men are members of the board of directors of the company. Mr. Gage is president of the Grace Chemical Co., and Mr. Geiger is president of the Davison Chemical Co. division of W. R. Grace & Co.

David M. Shapleigh has joined the staff of the Chemipulp Process, Inc., Watertown, N. Y., as a sales engineer. He will represent the company anywhere in the United States or Canada but his principal territory will be in Midwest pulp and paper mills.



A graduate of the pulp and paper course at the University of Maine, Mr. Shapleigh has been associated with the Brown Co., Hercules Powder Co., Paper & Industrial Appliances, and Jackson & Church Co. He has had broad experience in all phases of the paper industry, particularly in the field of equipment installation, service, and sales engineering.

Necrology

Henry K. Benson, professor emeritus of chemistry and former head of the department of chemistry and chemical engineering, University of Washington, Seattle Associated with that University since 1904, Dr. Benson retired in 1947 and served as a chemical consultant and research director of industrial chemical companies since that time.

Dr. Benson received his Ph.D. from Columbia. A man of diversified interests, he was employed for a time with the U. S. Department of Commerce; did field work with the Washington Geological Survey, and U. S. Bureau of Soils in soil survey and land classification; acted in the capacity of international delegate to the Chemistry Conference in Rome in 1938; was instrumental in bringing about the organization of the technical men of the West Coast pulp and paper industry; served as captain of the nitrate division of Ordnance Department of the Army in World War I; and became chairman of the division of chemistry and chemistry technology of the National Research Council in Washington, D. C.

(*Continued on page 94*)

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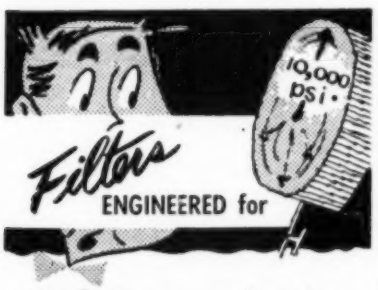
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CHEMICAL ENGINEER—B.Ch.E. New York University, 1951. World War II and Korea veteran. Married, no children. Quality control (statistical) with a leading mechanical rubber goods manufacturer. Knowledge of compounding. Textile experience, dye application. Mechanically inclined. Desire position with opportunity and advancement. Box 23-11.

PROJECT ENGINEER—Oil refinery and petrochemical plant design and construction. Diversified background including project, process, and operation experience. B.S.Ch.E. Registered. Want permanent responsible supervisory position. Box 24-11.

CHEMICAL ENGINEER—TECHNICAL SALES—Age 29, married. Three years' refinery experience and three years' industrial sales experience with large Midwest oil company. Interested in a responsible sales position. Prefer a Midwest or Western location. Box 25-11.

PROJECT ENGINEER—Twenty years' experience in construction project management and general engineering for major contractor and chemical plant. Married, 42, and used to a good salary. Wish to locate near New York or Philadelphia. Box 26-11.

SALES—CHEMICAL ENGINEER—B.S.Ch.E. Desire technical sales offering continuing challenge and opportunity in chemical or allied field. Five years' sales experience, currently sales manager. Age 30. Family. Veteran. Prefer location Pacific Northwest. Available for interview on West Coast. Box 27-11.

CHEMICAL ENGINEER—PRODUCTION MANAGEMENT—Age 32. Eight years' experience includes five years as assistant plant manager and three years in administrative staff positions. Desire position with broad responsibility for production operations. Reply Box 28-11.

CHEMICAL PROCESS—PROJECT ENGINEER—M.S. Five years' chemical plant operations, eight years' petroleum and petrochemical design and construction experience as process and project engineer. Available for responsible position leading to administration with expanding, aggressive company. Minimum salary $9,000. Box 29-11.

CHEMICAL ENGINEER—Ph.D., P.E. (N.Y.). Age 37. Three years' academic, eight years' industrial experience in process design, project engineering, research, development, production administration in petroleum, petrochemical, electrochemical industries. Patents, publications, honor societies. Desire responsible position. Box 30-11.

PRODUCTION MANAGER—Chemical engineer with twenty years' diversified experience in the fine chemical, antibiotics and pharmaceutical field. Would like the challenge of a responsible position with a smaller company which is expansion-minded. Especially interested in Western locations. Box 31-11.

CAPABLE, VERSATILE, MATURE CHEMICAL ENGINEER—Seven years' process design; three years' operations and trouble shooting; five years' evaluations (technical, process, economic); nine years' teaching, evenings (graduate level). Prefer position responsibility, challenge. Head up small chemical engineering department; be assistant to manager, large department; be technical assistant to demanding executive. Patents, publications, advanced degrees; Sigma Xi, Phi Lambda Upsilon, A.I.Ch.E., A.C.S. Salary required $12,000-$15,000 annually. Box 32-11.

M.S. (Ch.E.)—Dynamic young leader in development, market research, and economics in organics, fine chemicals, polymers. Record of organization, administration, and results. Temporarily stymied. Wanted: opportunity for action. $14,000. Box 33-11.

TECHNICAL SERVICE OR SALES ENGINEERING—B.Ch.E., M.B.A. Credits towards doctorate. Age 34, married, veteran. Nine years' industrial experience, five years in active selling and four years in development and research. Willing to travel. Box 34-11.

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CHEMICAL ENGINEER—Bachelor's degree, 1948. Diversified background in metallurgy, pilot plant research in manufacture of lubricating grease and food products; and safety, fire prevention and plant protection. Desire permanent position. Age 32, married. Box 35-11.

FOR

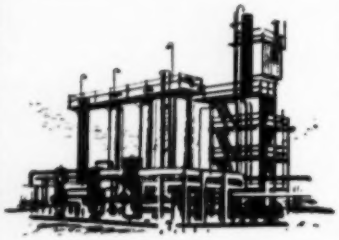
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NECROLOGY (*Continued from page 91*)

Ward Ely Pratt, chemical consultant of the centrifugal pump division, Worthington Corp., Harrison, N. J. He received an M.E. degree in mechanical engineering from Cornell University, Ithaca, N. Y., in 1914 and early in his career was identified with the Sill Stove Works, Rochester, N. Y., and later with the Duriron Co., Inc. In between these two assignments he was research associate, University of Illinois.

Ralph H. McCormack, professor of chemical engineering at the University of Detroit.

Professor McCormack, at the time of his death on Oct. 2, was working on two classified research projects, one for the National Science Foundation, and another for the Department of Defense. He was also consultant for the N.S.F.'s saline water commission on a nationwide project.

A graduate of the University of Chicago, who held a doctorate from Virginia Polytechnic Institute, Professor McCormack went to the University of Detroit in 1951 after fifteen years as associate professor of chemical engineering at Pratt Institute, Brooklyn, N. Y. He had also worked with E. A. Siebel and Co., Brooklyn, the Sanitary District of Chicago, and the Prima Brewing Co., also of Brooklyn. He was a consultant chemist for the Baker Castor Oil Company of New Jersey, and the National Lead Research Laboratories of South Amboy in New Jersey.

Theodore A. Petry, senior engineer, The Texas Co., New York, N. Y. He held a B.S. degree in commercial chemistry from Pennsylvania State College and a B.Ch.E. degree from Polytechnic Institute of Brooklyn, Brooklyn, N. Y. For a short time he served as technician with the Consolidated Edison of New York.

IN MEMORIAM

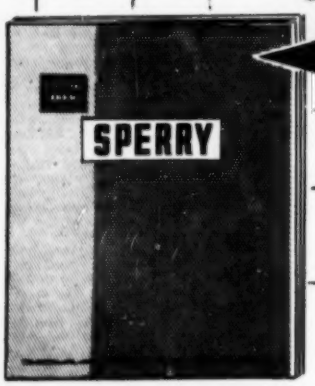
A memorial scholarship fund is being raised by the friends of the late Geoffrey Broughton (see CE.P., October, 1954, page 100) to establish a scholarship at the University of Rochester. Checks for the fund are to be made payable to the University of Rochester and addressed to:

Geoffrey Broughton Scholarship Fund
c/o Dr. Lewis Conta, Chairman
Division of Engineering
University of Rochester
Rochester 3, N. Y.

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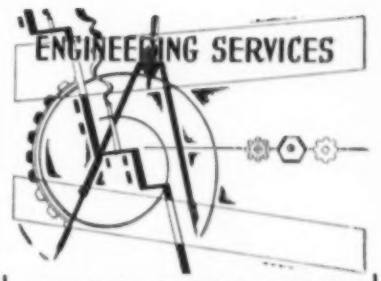
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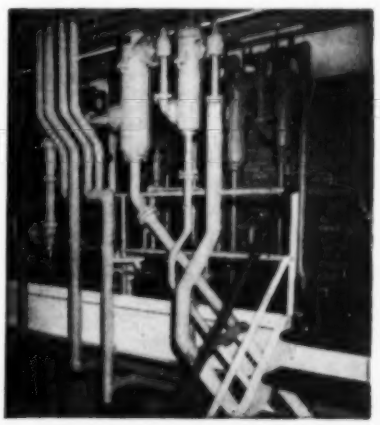
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A.I.Ch.E. News And Notes

Recent change in membership nomenclature also brought a problem in Junior award name . . . originally called Junior Award, it was changed some years ago to Junior Member Award . . . Awards Committee has been working for some time on a better name & voted to recommend to Council, Founders' Award. Council decided that this title should be reserved for special commemorative medals to be awarded at the Institute's 50th Anniversary Meeting in Philadelphia in 1958. Name is again Junior Award . . . but the Committee is still seeking another title.

Plans for new A.I.Ch.E. Journal are crystallized...First issue of the new quarterly will be March, 1955, with three additional volumes in June, September & December...Members have received notice & opportunity to subscribe in the recent program mailing of Annual Meeting. Subscription price is $4.50 to members; $9.00 to non-members.

Journal is expected to have between 650 & 750 pages a year of technical matter. Content essentially will be new research developments & theoretical advances in chemical engineering. Professor Harding Bliss of Yale University, as already mentioned in C.E.P. news pages, will be editor.

The Council's appointment of committee chairmen is practically finished for 1955. Admissions, D. H. Spitzli; Awards, R. H. Wilhelm; Chemical Engineering Education & Accrediting, R. A. Morgen; Constitution & By-Laws, W. T. Dixon; Equipment Testing Procedures, W. R. Marshall, Jr.; Industrial Waste Disposal, G. F. Jenkins; Institute Sections, S. L. Lopata; Membership, J. W. Schall; Professional Development, R. Voorhees; Professional Legislation, Lee Van Horn; Program, George Armistead, Jr.; Research, H. L. Malakoff; Student Chapters, D. E. Holcomb; Vocational Guidance, C. B. Roen; Public Relations, Robert York.

Membership Committee results this year are slightly behind that of 1952 their most successful year to date ... J. W. Schall is chairman of the group.

Some local sections offer prizes to members who bring in a specified number of applications ... Philadelphia-Wilmington offering prizes for five or more.

Other sections of the country, according to J. J. McKetta (South Texas) Vice Chairman of the committee, break down territories into areas of chemical activity and assign a sub-committee ... companies in sub-committee are assigned at least one local membership committee member to each plant.

Contest in the membership race between local sections is a runaway for South Texas which has 67 new membership applications so far this year; Philadelphia-Wilmington the runnerup has 38.

Members of committees result from joint action of the committee chairmen & Council, & will be appointed later.

New Student Chapter Councillors: D. H. Archer, Carnegie Institute of Technology; F. N. Peebles, University of Tennessee; Dudley Thompson, Virginia Polytechnic Institute.

The second committee of the Institute to come up with a News Letter is the Professional Development Committee (Local Sections was first)...Editor of the News is W. E. Keppler, with Merck & Co. at Danville, Pa. First news letter detailed nine different projects which the Committee is now working on.

W. L. Bolles of the Institute's Public Relations Committee has just completed a rough draft of a report on how to organize & operate a local section Speakers' Bureau...Speakers' Bureau supplies technical speakers to non-technical audiences & 18% of our local sections have bureaus now in operation according to survey which Bolles ran.

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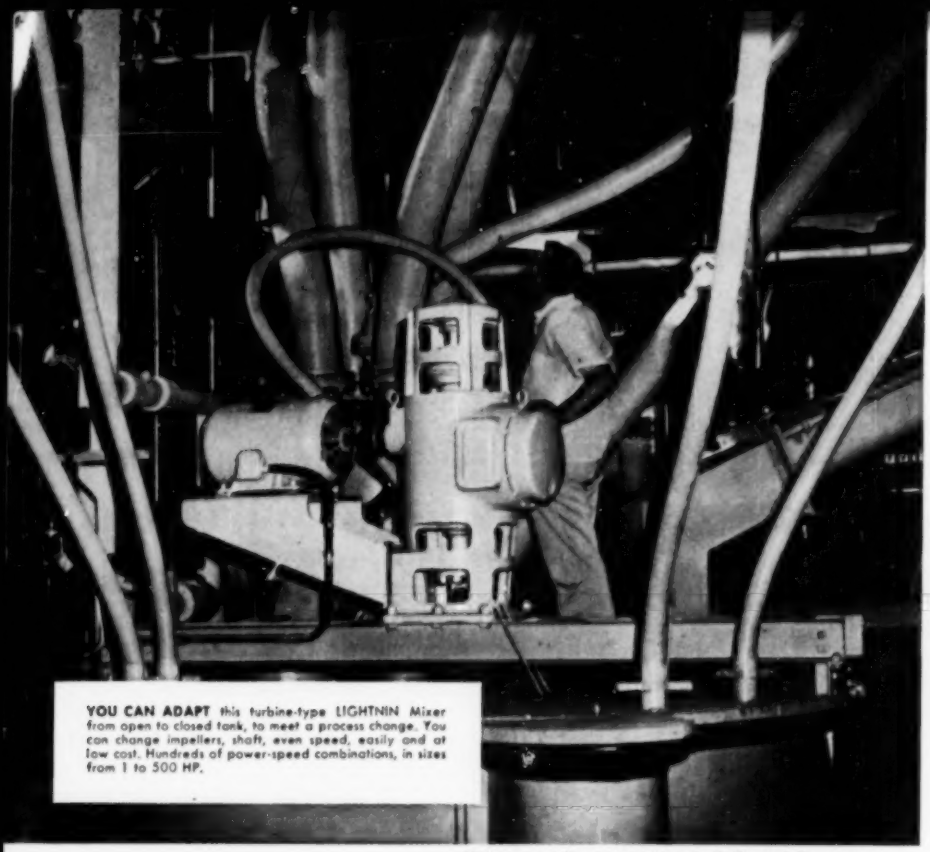
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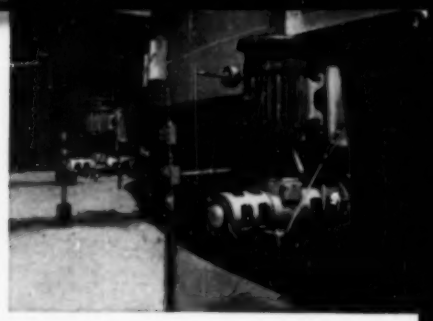
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